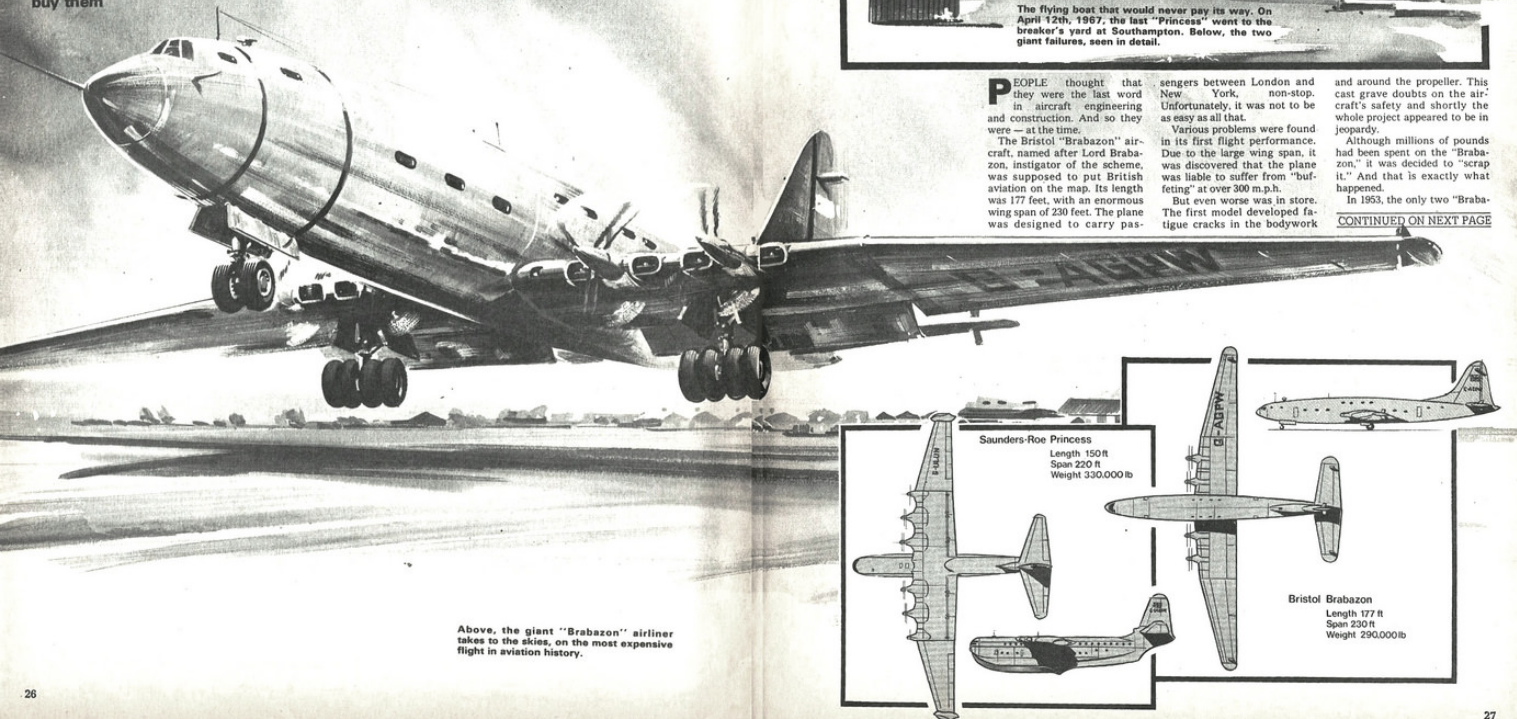


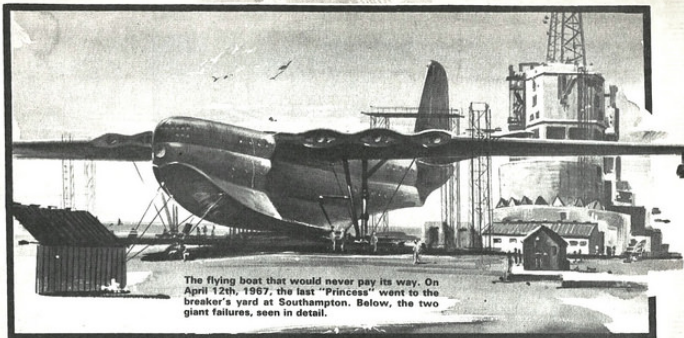
WHY DID THEY FAIL?

The White Elephants of the Air

Does size mean success? The aircraft industry in the 1950s thought so. Technicians, designers and factory workers united in producing two huge planes which were supposed to span the world. The only trouble was that nobody wanted to buy them



Above, the giant "Brabazon" airliner takes to the skies, on the most expensive flight in aviation history.



The flying boat that would never pay its way. On April 12th, 1967, the last "Princess" went to the breaker's yard at Southampton. Below, the two giant failures, seen in detail.

PEOPLE thought that they were the last word in aircraft engineering and construction. And so they were—at the time.

The Bristol "Brabazon" aircraft, named after Lord Brabazon, instigator of the scheme, was supposed to put British aviation on the map. Its length was 177 feet, with an enormous wing span of 230 feet. The plane was designed to carry pas-

sengers between London and New York, non-stop. Unfortunately, it was not to be as easy as all that.

Various problems were found in its first flight performance. Due to the large wing span, it was discovered that the plane was liable to suffer from "buffeting" at over 300 m.p.h.

But even worse was in store. The first model developed fatigue cracks in the bodywork

and around the propeller. This cast grave doubts on the aircraft's safety and shortly the whole project appeared to be in jeopardy.

Although millions of pounds had been spent on the "Brabazon," it was decided to "scrap it." And that is exactly what happened.

In 1953, the only two "Brabazon" flying boats were broken down for scrap. The only surviving part of the giant airliner can be seen nowadays in the Science Museum, London.

Another British achievement doomed to failure, was the "Princess" flying boat. It was hailed as a major breakthrough, and once more, millions of pounds were lavished on it.

But here again, various "snags" cropped up and the whole future of the "Princess" project was shadowed by clouds of uncertainty. "Engineering problems," whispered the newspapers, although the Go-

vernment was quick to deny these rumours.

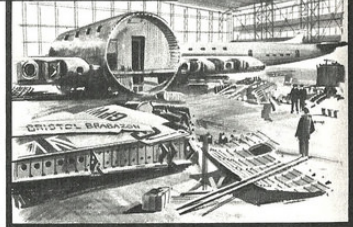
It was suggested that some kind of nuclear power would propel the "Princess." But after months and finally, years, of doubts and troubles, the whole enterprise had to be abandoned.

Factory employees who had worked on the "Princess" for years, were upset, because they had come to develop an affection for the flying boat and were convinced that it could still be salvaged. However, sentiment

Perhaps this is the way most people would like to remember the "Princess" flying boat, skimming the waves before soaring into the sky to reach its maximum cruising speed of 360 m.p.h.



Left, the beginnings of a dream in 1947 where two massive hangars were specially built to house the "Brabazon." Below, the end of a dream, a glistening aircraft is turned into scrap metal.



comes a bad second to finance in this modern world of ours.

One sad April day in 1967, the only "Princess" which had ever taken to the sky, was towed across the water from the Isle of Wight to Southampton. There the breaker's yard claimed this marvellous and expensive piece of engineering and craftsmanship.

Why did both these vast avia-

tion projects fail? Why should they have failed? Some of the best brains in the British aircraft industry were engaged in making them as safe and secure as possible. So what went wrong?

Who knows? Even the Concorde, the product of British and French engineering skill and "Know-how," still has a question mark hanging over its future.



LOOK AND LEARN

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THE FLYING FERRY

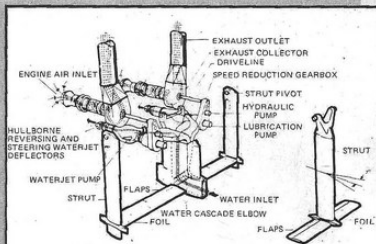
See Inside



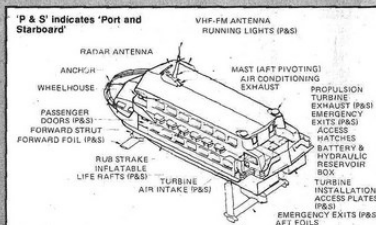
Speed & Power

THE FLYING FERRY

This is the Jetfoil, which flies across the waves propelled by the water beneath it



The motive power for the Jetfoil is provided by two gas turbine engines. Water is drawn in from an inlet on the foils and then pumped through waterjet nozzles. The craft has no rudder, but is steered by deflecting the jet of water.



The Boeing Jetfoil. Cruising Speed: 43 knots. Displacement: 110 tons. Length: 90 feet (27.4 metres). Beam: 31 feet (9.5 metres). Draught: foils down 17 feet (5.2 metres), foils up 5.5 feet (1.7 metres). Propulsion: gas turbine-waterjet. Capacity: 190-420 passengers.

An exciting new form of cross-Channel transport has joined the hovercraft and conventional ferry ships which carry passengers between Britain and the continent of Europe. It is a high-powered hydrofoil vessel that has been designed and built by the Boeing Aerospace Company of America, who are also well-known for building the great 707 airliner and the 747 Jumbo Jet.

Boeing's new sea vessel is called the Jetfoil. Several of these remarkable craft are operating in such other parts of the world as Hawaii, Japan and Hong Kong, where passengers who travel in them have described the sensation as rather like "flying just above the surface in an aeroplane". The cross-Channel service, which uses the only Jetfoil in Europe at the moment, is operated by the old-established British Shipping company, P & O.

Leaving its berth just below the Tower of London, the Jetfoil rises on its "wings" and skims down the River Thames, before crossing the North Sea on its way to the Belgian port of Zeebrugge. The journey takes about three-and-a-half hours. The principle of the hydrofoil is a simple one which has been known for some time. In fact, the first experimental hydrofoil was steam driven, and ran on the River Seine near Paris in 1891. It was designed by a Frenchman named Count de Lambert. The Americans Wilbur and Orville Wright, who were the first men to achieve powered flight, also made some runs with a hydrofoil in 1907.

At low speeds, a hydrofoil floats in the water like an ordinary boat, but as it gathers speed, the hull rises out of the water on to small, wing-like structures that extend below its hull. The main part of the vessel is then hurtling through the air,

and because air is much less dense than water, less power is required to thrust it along. In fact, only about half the horsepower is needed to drive a hydrofoil when it is riding on its "water-wings", that would be needed by a conventional speedboat moving at a similar speed.

The Boeing Jetfoil has fully-submerged foils, while some other similar vessels have surface-piercing foils which make use of an inclined wing to lift the hull clear of the water. Although the surface-piercing type are effective, they are subject to wave action in rough seas which affect the stability of the vessel.

The fully-submerged "wings" of the Jetfoil lift the hull well above the waves while remaining below their disturbing influence themselves, thus giving the vessel freedom from the motion of the sea's surface. Like an aircraft wing, the foils

have a hinged trailing edge, so that, when depressed or raised, increases or decreases its "lift".

In addition to this advantage, the "wings" or foils are connected to an automatic control system (ACS) that employs attitude and motion sensors. Even in quite severe sea conditions, the equilibrium of the hull is maintained to a remarkable degree, and passengers experience very little vertical or rolling motion.

Twin gas turbine engines of 3,700 hp each power the Jetfoil, which has no propellers. Instead, the engines drive high-performance pumps that force water through nozzles at the rear of the craft (see diagram), and give it a top speed of 48 knots in calm water, and a speed of 45 knots in a sea with 12ft (3.65m) waves. Normal cruising speed is 43 knots.

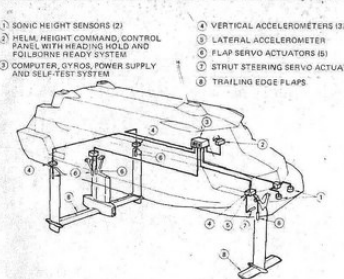
The foil system is fully retractable, rather like the undercarriage of an aircraft, so that, when the vessel is operating in shallow harbour waters, it can easily be manoeuvred up to a quayside to take on and discharge passengers.

The foils are clad with stainless steel shields which absorb the impact of any floating debris the Jetfoil may strike at speed. The makers claim that the struts will slice cleanly through logs up to 14 inches (350mm) thick. Should the struts supporting the foils strike more solid objects, they have a "fail-safe" device which allows them to fold up against the hull. With struts fully retracted the Jetfoil can travel like a conventional ship, but at about one third the speed.

The P & O Jetfoil has two decks for passengers, and carries 212 people with their baggage. Other versions can take 420 passengers on short haul commuter routes. The passenger decks have comfortable seating and are air-conditioned. There is also a small food and drinks bar.

Because the decks are well above the water level, there is no spray to obscure the view and almost no vibration from the smooth-running turbine engines. Unlike the hovercraft and conventional ferryboats, the Jetfoil cannot at present carry any vehicles, and in a calm sea is slightly slower than a hovercraft. But it comes into its element in seas like the Channel and the North Sea, which are fairly calm.

The London-Zeebrugge run is still on a trial basis. The Jetfoil has proved its worth in the heavy seas around Hawaii, but the North Sea, where the waves are much closer together, is notoriously rough. If the test period proves successful, the sight of a Jetfoil winging its way across the water may become a commonplace around our shores.



When foilsborne — up on the foils — the Jetfoil is controlled by its Automatic Control System. Craft motions are sensed by gyros, accelerometers and height sensors. The signals go into a computer which flashes out directions to the flaps on the trailing edges of the foils.

The Plane That Searches The Seas

The Lockheed P-3C Orion has become the most popular maritime-patrol plane in the countries of the Western world



THE Second World War had underlined the importance of submarines in naval warfare strategy. So, as they improved in speed and design following the war, it became obvious to the top planners of most navies that new and efficient anti-submarine systems were vital.

In August, 1957, the US Navy requested aircraft companies to produce plans for an anti-submarine patrol plane based on a conventional aircraft design. The successful proposal came from the Lockheed-California company with their *Lockheed P-3 Orion*, which was basically a conversion of the existing Electra airliner.

The P-3 went into production in 1962 and was soon in service with navies in all parts of the world; those of the USA, Canada, Australia and New Zealand among them. As well as serving in submarine and ship detection, these planes were used for weather reconnaissance.

But submarines continued to grow in sophistication, with their designers and engineers producing

improved systems for avoiding detection. So the P-3 had to be modified if it was to fulfil its major role. And in 1968 a completely different version — the *Lockheed P-3C Orion* — came into operation, making its first flight on 18th September of that year.

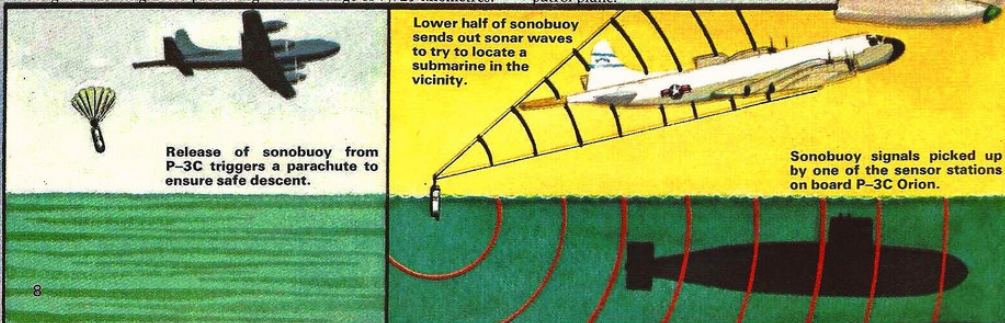
Within the same airframe this had a completely up-to-date tactical system in which the sensors and weapons were controlled by a digital computer. However, improvements have continued to be made. The P-3C Update, first produced in 1977, has a vastly increased computer capacity, global navigation system and more accurate sensory devices.

Our cutaway illustration shows the major features of the P-3C. With a length of 35.61 metres and a span of 30.37 metres, it is powered by four single-shaft turboprop engines. Although the propellers may make the plane look dated, the P-3C is no slouch! It has a maximum speed of over 750km/h (in 1971 a US Navy crew set a record of just over 800km/h) and a range of 7,725 kilometres.

Besides the computer and sensory machinery, the P-3C has a built-in radar system in the nose and at the tail. A varied load can also be stowed, including two depth bombs, four anti-submarine torpedoes, and 87 sonobuoys, which are of vital importance in submarine detection.

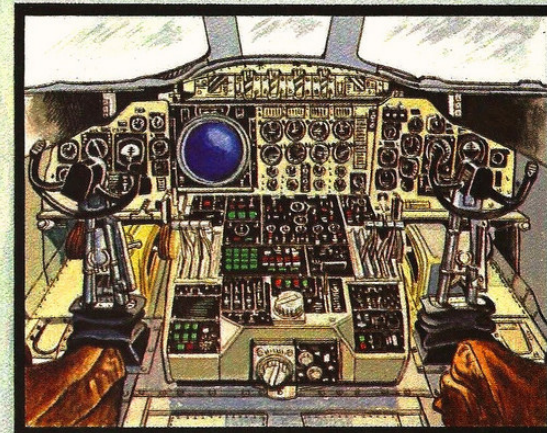
There are chutes or launch-tubes for 52 sonobuoys. One chute can be operated manually while the others are computer-controlled. The tubes are angled to make sure that the sonobuoys are equally spaced across the detection area. A small parachute is released so that the sonobuoys descend steadily and are not damaged as they strike the water's surface. The lower half of the sonobuoy sends out sound waves which may be interrupted by a submarine. A signal is then transmitted back to the sensor station on board the P-3C for interpretation.

Research goes on to improve detection methods, but the P-3C retains its place among Western navies as their favourite maritime-patrol plane.



Some of the insignia of P-3C anti-submarine squadrons in the US Navy.

The complex control panel in the cockpit of the P-3C.



... this week invites you to come aboard the Queen Elizabeth 2, the liner that provides its passengers with ...

ASK anyone to name the world's most famous passenger liner afloat today, and the chances are that the name they will call to mind is *Queen Elizabeth 2*. Operated by the Cunard line, this vessel was launched in 1969 and now sails the seas as a luxury floating hotel.

During the coldest winter months, she earns revenue for Britain by carrying tourists on a world cruise. From April until December, the ship is busy on transatlantic journeys, interspersed with cruises to the Caribbean, the Canary Islands and the Norwegian fjords.

She has gained a place in the record books as the world's largest liner, being 294 m long, with a breadth of 32 m, and a gross tonnage of 67,139.

Although she is a vast ship, the QE2's overall dimensions allow her access to most ports in countries that are attractive to cruise passengers. Her 110,000 hp turbines give her a service speed of 28½ knots, and, although her graceful hull is slightly smaller than those of previous Cunard Queens, it provides better accommodation and amenities for an equal number of passengers.

Aboard, there is a world of luxury for up to 1,815 passengers accommodated in cabins on five of her 13 decks, three of which are devoted to public rooms and passenger services.

These include two huge restaurants, grill rooms, a cinema, a discotheque, four swimming pools (two indoors), sauna and

The Last Word In Luxury

Turkish baths, ten lounges, two nightclubs, a shopping arcade, two libraries and a fully-equipped hospital. The ship also has drive-on/drive-off facilities for 70 cars.

In order to remain operational, the QE2 carries a total of 1,000 officers and crew — 300 less than either of the two previous Queens (*Mary* and *Elizabeth*). They, too, have comfortable quarters, with their own swimming pool and entertainment facilities.

The QE2 is the latest in a proud "family" of ships with royal names. Its most famous predecessors are two sister ships which formed a partnership which was to become legendary.

The hull of the *Queen Mary* was laid down in 1930 at Clydebank, but work on her was halted when an economic gloom settled over the country. For 2½ years a great silence hung over the shipyard.

When at last salvation arrived, it was due to government intervention. Facing up to the fact that the two great shipping companies, Cunard and White Star, were now in an equally shaky economic position, the British government, who wanted to see British prestige on the North Atlantic run rejuvenated, offered them a huge loan. The condition was that the companies should merge.

The offer was accepted, and in April, 1934, work was resumed on the *Queen Mary*. Six months later, she was ready for launching.

The publicity given to her was enormous, and statistics ran riot. Pictures of her showing how she would appear if put down in Trafalgar Square in London were drawn. The crown of Nelson's column reached barely to her boat deck. Her power, someone pointed out, was equal to that provided by seven million galley slaves!

Despite all that, she rolled. In the years before stabilizers were fitted, passengers wondered how so vast a vessel could smash so much crockery and toss those who travelled in her out of their bunks.

Nevertheless, in 1938, she established a record for making the fastest Atlantic crossing. She had taken this record from the French liner, *Normandie*, and retained it until 1952.

The *Queen Elizabeth* came into service in 1940 when Britain was at war with Germany. Both she and the *Queen Mary* spent the next few years carrying troops. Their greatest value was on the North Atlantic run, where their great speeds made them almost immune to U-boat attacks.

The one unhappy occurrence took place in 1942, while *Queen Mary* was in the company of the

British cruiser, *Curacao*. The two ships got their signals mixed, with the result that the great liner struck the warship with such force that it set her spinning. Then the *Queen Mary* ran over her. As a result, 338 of the cruiser's crew were killed.

After the war, the two vessels took up their peace-time partnership. The pair continued to dominate the Atlantic until well into the 1960s. In September, 1967, with the *Mary* now 31 years old, and the *Elizabeth* in her 27th year, they passed each other for the last time on the Atlantic run.

The *Mary* was saved from the scrap-yard and now rests at Long Beach, California, as a hotel museum and convention centre.

The *Elizabeth* was sold to take up a similar role at Port Everglades, Florida, in 1968. But as this did not prove to be a success, she was sold to the Orient Overseas Line. She was taken to Hong Kong to serve as a floating marine university and renamed *Seaview University*. She was gutted by a fire on 9th January, 1972.

The proud tradition of Cunard is carried by the QE2 and other vessels operated by the line.

Cunard's Challenge

SAMUEL CUNARD, who was the founder of the Cunard line, was an idealist with a hard practical sense. In 1838, this man of Welsh ancestry was running mail ships out of Halifax, Nova Scotia, to and from Newfoundland, Boston and Bermuda. In that year, the British government invited tenders for a regular service of steam-packets to carry mails across the North Atlantic.

Hitherto, mails had been carried from Europe to America in ships of sail under conditions of stark discomfort for any passengers hardy enough to endure many weeks at sea. There was no guarantee when these ships would reach their destination.

Cunard's tender was accepted and a contract worth £60,000 a year was his. On 4th July, 1840, Cunard's first ship, a wooden paddler of just over 1,000 tons, left Liverpool for Boston with 115 passengers and 225 tons of cargo, including mail. This was the

Britannia, which thumped along at a steady eight knots.

On her decks were a bakery and a cow house. Down below, the cabins were rugged, with narrow, wooden berths and oil lighting. Nevertheless, this vessel was luxurious compared with the ships which had preceded it.

Thirty-eight tons of coal were burned on every one of the 14 or more days which it took *Britannia* to reach Boston via Halifax.

Three more "sisters" were built for *Britannia*. One of these was the *Hibernia*, which became the first Cunarder to steam into New York. In the 1850s, the first iron-built ships appeared. Among these was the *Andes*, whose saloon was described as a "stupendous apartment". She was the first of the fleet to discard paddle-wheels in favour of the more efficient screw propulsion.

Passengers, however, liked to see paddle-wheels churning round, because it gave them a feeling of power. Cunard built a huge paddle-ship, *Persia*, which burned 150 tons of coal a day and required so much space for her coal that there was room only for cargo and none for passengers.

The screw-driven *China* of

1862, which burned only 82 tons of coal a day, and had ample room for passengers, opened a new chapter. Sail was finally doomed.

Cunard — by now Sir Samuel Cunard — died in 1865. More than any other man, he had brought about the conquest of the Atlantic by steam. Ships such as *China* and *Persia* were crossing the Atlantic in about nine days.

Cunard lived to see his Atlantic timings rivalled, then clipped, by the American Collins Line. But after his death, his company continued to work for their continued supremacy in the Atlantic.

In 1881, there came the 7,000 ton *Servia*, Cunard's first steel ship, and also the first to be lit by electricity.

After the turn of the century, Cunard set about building a pair of ships that were to exceed all others. These were the *Mauretania* and *Lusitania*, both of 32,000 tons. They were the most graceful, powerful and comfortable steamships ever seen.

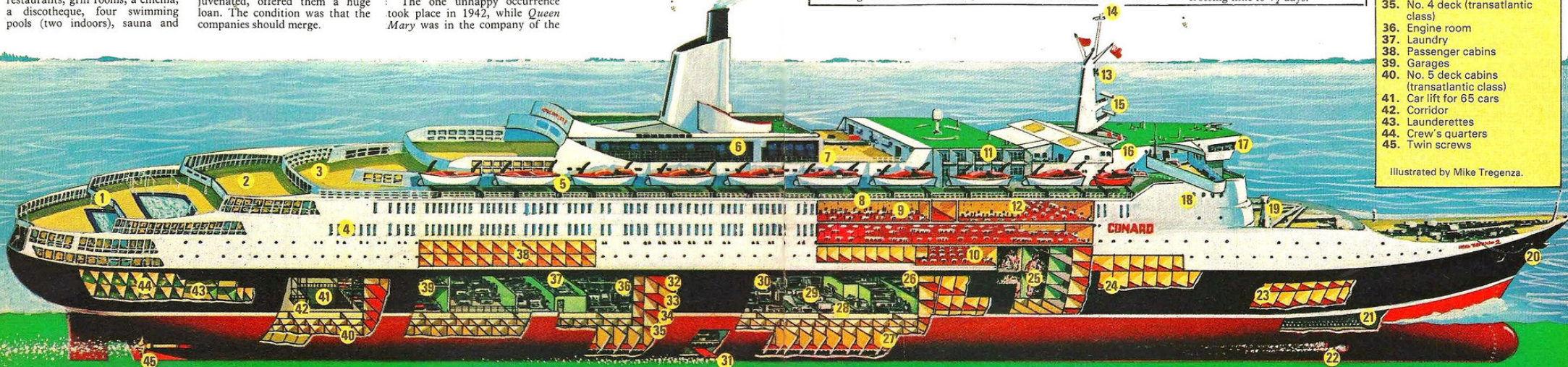
Both ships, turbine-engined, entered the Atlantic run in 1907 and reached over 25 knots.

These were the wonder ships of their times, reducing the Atlantic crossing time to 4½ days.

This Is The QE2

1. Recreation decks with swimming pools
2. Upper deck
3. Boat deck
4. Quarter deck
5. Boat deck
6. Sports deck
7. Children's playrooms
8. Theatre (beyond bulkhead)
9. First-class lounge
10. Restaurant (transatlantic class)
11. De luxe suites
12. First-class restaurant
13. Sirens
14. Satellite aerial
15. Radar scanners
16. Signal deck
17. Bridge and chart room
18. Officers' quarters
19. Starboard cargo derrick
20. Three anchors, port, starboard and bow, each weighing 12½ tons
21. Refreshment store
22. Twin bow thrusters of 1,000 hp each
23. First-class passenger cabins
24. Transatlantic class cabins
25. Refrigerated stores
26. Printing shop
27. No. 5 deck cabins
28. Corridor
29. Turbo-alternator room for heating and lighting
30. Boiler room
31. Stabilizer (extended)
32. No. 1 deck (first class)
33. No. 2 deck (first class)
34. No. 3 deck (first class)
35. No. 4 deck (transatlantic class)
36. Engine room
37. Laundry
38. Passenger cabins
39. Garages
40. No. 5 deck cabins (transatlantic class)
41. Car lift for 65 cars
42. Corridor
43. Launderettes
44. Crew's quarters
45. Twin screws

Illustrated by Mike Tregenza.



HARDY'S DRAWING BOARD

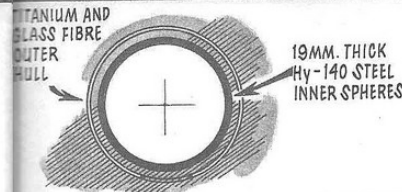
This week we look at DSRV's...

The Deep-Sea "Lifeboats"

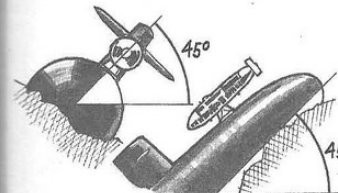
THE HISTORY OF SUBMARINES INCLUDES DISASTERS AND RESCUE ATTEMPTS - SOME SUCCESSFUL, SOME NOT. ON MAY 23, 1939, THE U.S. NAVY'S SQUALUS WENT DOWN BUT THE SURVIVORS WERE SAVED BY DIVING BELL FROM THE THEN INCREDIBLE DEPTH OF NEARLY 75 METRES. THE MOST STUNNING DISASTER OF MODERN TIMES WAS THE LOSS OF THE NUCLEAR-POWERED USS THRESHER (LEFT) WHICH DISAPPEARED ON APRIL 10, 1963, IN THE WILKINSON DEEP OFF NEW ENGLAND. 129 MEN PERISHED NEARLY 2,500 METRES DOWN. ONLY TWO SUBMERSIBLES COULD REACH SUCH DEPTHS, AND THE TRIESTE (BELOW) SPENT FIVE MONTHS SEARCHING...

... BEFORE FINDING WRECKAGE, CRUSHED AND TWISTED BY THE ENORMOUS PRESSURE. THE RESULT OF THE THRESHER TRAGEDY WAS AN IMMEDIATE START ON RESEARCH INTO A SPECIAL RESCUE SYSTEM TO OPERATE AT DEPTHS OF UP TO 1520 METRES - THE MAXIMUM DEPTH AT WHICH SURVIVAL COULD BE EXPECTED. THE LOCKHEED CORPORATION DESIGNED AND BUILT TWO DSRV'S (DEEP SUBMERGENCE RESCUE VEHICLES).

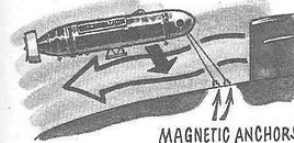
THESE ARE NOW FULLY OPERATIONAL WITH THE U.S. NAVY. 15.24 M LONG AND 2.4 M IN DIAMETER, THE DSRV'S USE SONAR TO TRANSMIT SOUND WAVES FOR NAVIGATION AND FINDING THE SUNKEN SUBMARINE. POWERFUL LIGHTS, TV CAMERAS AND SPECIAL VIEWPORTS ENABLE THE CREW TO SEE INTO THE DEEP DARKNESS AS THEY PLACE THEIR VESSEL OVER THE SUB'S HATCH. THE DSRV IS OPERATED BY A THREE-MAN CREW AND CAN QUICKLY RESCUE A SUB'S ENTIRE CREW, TAKING 24 AT A TIME.



THE SEVERE DESIGN CONSTRAINTS APPLIED TO THE DSRV WERE CAUSED MAINLY BY THE NEED TO MAKE ITS SIZE AND WEIGHT SUCH THAT IT COULD BE TRANSPORTED BY AIR. DSRV HAS TWO HULLS - AN OUTER ONE (NOT WATERTIGHT) TO GIVE IT A STREAMLINED SHAPE AND TO HOUSE EQUIPMENT, AND THE THICK, WATERTIGHT INNER SPHERES.



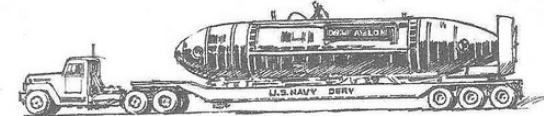
THE DSRV MAY NOT FIND THE DISTRESSED SUBMARINE LYING CONVENIENTLY UPRIGHT. BUT IT CAN ATTACH ITSELF AT AN ANGLE OF UP TO 45°, AS SHOWN.



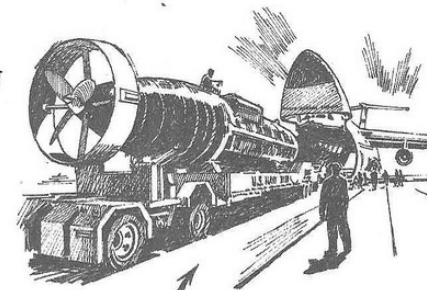
SHOULD THE DSRV PILOTS FIND THAT A STRONG UNDERWATER CURRENT IS PULLING THE CRAFT OUT OF POSITION, THEY CAN RELEASE MAGNETIC ANCHORS, AND ANCHOR WINCHES WIND IN THE CABLES TO PULL IT DOWN.

NOTE: - IN THE PHOTO OF HMS REPULSE WITH DSRV-2 "AVALON" ATTACHED, THE WHITE MARKINGS PAINTED ON THE RUDDER, DECK AND CONNING TOWER OF THE REPULSE ARE TO HELP THE DSRV PILOTS POSITION THEMSELVES UNDERWATER.

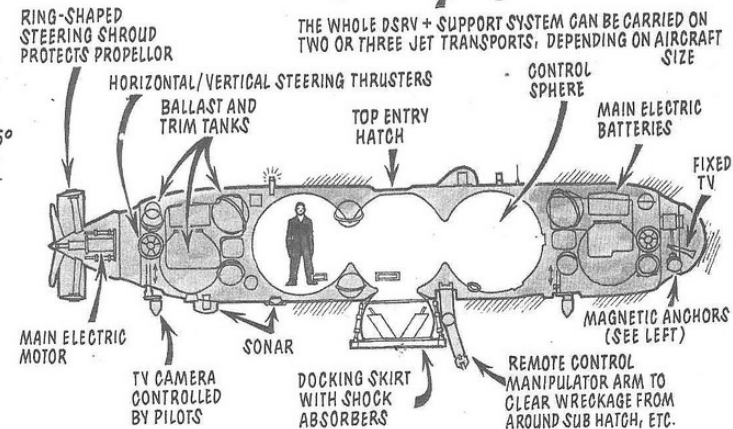
* DSRV-1 IS NAMED "MYSTIC".



SINCE SUBMARINES PATROL EVERY OCEAN IN THE WORLD, THE RESCUE SYSTEM MUST WORK ON A "GO ANYWHERE - QUICKLY!" BASIS. THE AIM IS TO BE ON ACTUAL RESCUE WORK WITHIN 24 HOURS OF A DISTRESS CALL. THE DSRV AND ITS SUPPORT UNITS CAN TRAVEL BY AIR AND ROAD AND PUT TO SEA ON A RESCUE SHIP OR CAN BE CARRIED "PIGGY-BACK" ON ANOTHER FULL-SIZE SUBMARINE (SEE PHOTO BELOW).



THE WHOLE DSRV + SUPPORT SYSTEM CAN BE CARRIED ON TWO OR THREE JET TRANSPORTS, DEPENDING ON AIRCRAFT SIZE

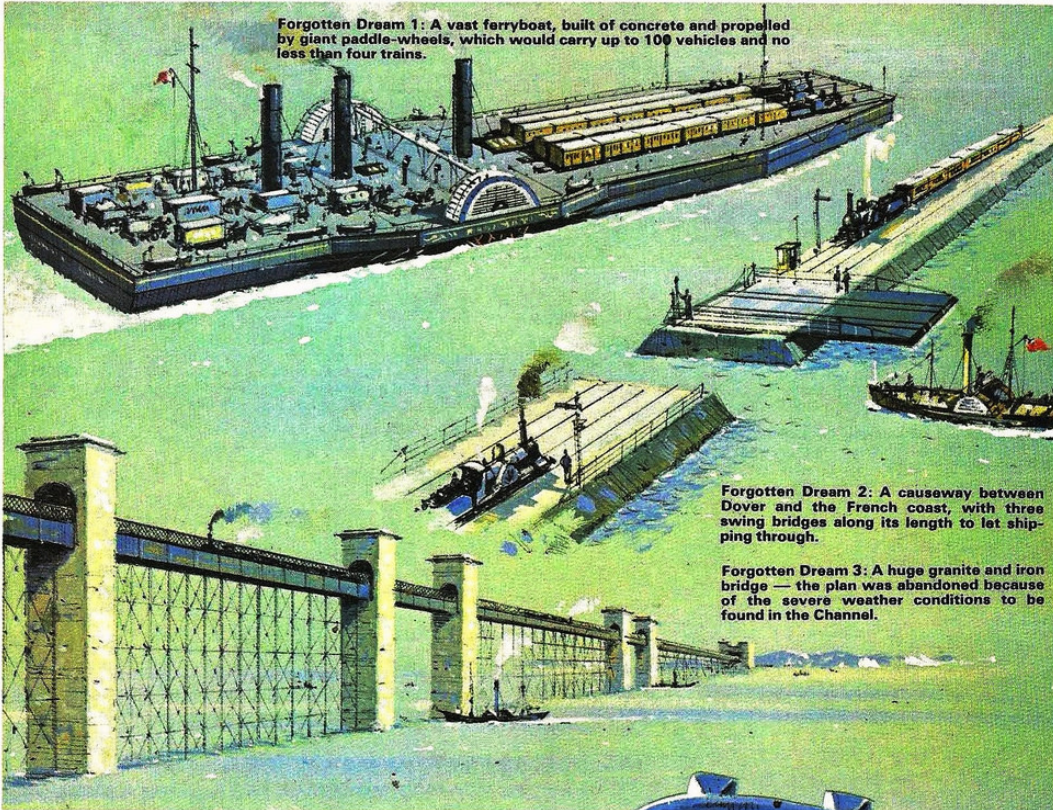


THIS CUTAWAY SHOWS THE LAYOUT OF A DSRV'S EQUIPMENT AND THE THREE STEEL SPHERES. THE DOCKING SKIRT IS AN INTEGRAL PART OF THE CENTRE SPHERE. MUCH OF THE EQUIPMENT IS IN BOTH FORE AND AFT POSITIONS BUT IS ONLY LABELLED ONCE. IN FACT, THERE ARE MANY SONAR POSITIONS FOR DIFFERENT PURPOSES.

THE TECHNIQUES FOR FAST, EFFICIENT RESCUES HAVE BEEN STEADILY DEVELOPED AND COMPLETE EXERCISES CARRIED OUT. FOR ONE, IN RESPONSE TO A "SUBSUNK" DISTRESS CALL, A DSRV WITH ALL SUPPORT SYSTEMS WAS FLOWN IN TWO LOCKHEED JET TRANSPORTS FROM SAN DIEGO TO ALL GLASGOW. THE DSRV WENT BY ROAD TO THE CLYDE NAVAL BASE AND WAS LOADED ABOARD THE NUCLEAR SUBMARINE HMS REPULSE (BELOW). REPULSE SET SAIL TO THE SCENE OF THE "ACCIDENT", DIVED AND RELEASED THE DSRV. THIS SUCCESSFULLY FOUND HMS ODIN AND REPEATEDLY TRANSFERRED CREW MEMBERS TO THE STILL-SUBMERGED REPULSE.



Forgotten Dream 1: A vast ferryboat, built of concrete and propelled by giant paddle-wheels, which would carry up to 100 vehicles and no less than four trains.



Forgotten Dream 2: A causeway between Dover and the French coast, with three swing bridges along its length to let shipping through.

Forgotten Dream 3: A huge granite and iron bridge — the plan was abandoned because of the severe weather conditions to be found in the Channel.

A Dream That Survives: Interest in the idea of a Channel tunnel has never flagged, although, much as many would like it, it now seems unlikely that it would ever be used by cars and forries.



Wake Up—It's Paris

We conclude our series on cross-Channel travel with a look at a service that has disappeared, some wild ideas which thankfully never came to fruition, and the grandest idea of them all — a tunnel linking Britain with France

THE bigger the challenge, the bigger the solution to it — and challenges rarely come larger than the stretch of water called the English Channel. Crossing it by a more convenient means has always excited the interest of inventors and public alike, and for many a tunnel has remained the obvious answer.

A survey for a tunnel under the sea was begun as long ago as 1832 by a French engineer-cum-geologist, Thomé de Gamond. It took him 35 years, and his method for making soundings and measurements was simplicity itself. De Gamond's equipment consisted of two pieces of lint to cover his ears, a satchel full of stones over his shoulders for ballast, and air-filled pigs' bladders round his waist.

Diving from a rowing-boat, the Frenchman was weighed down by

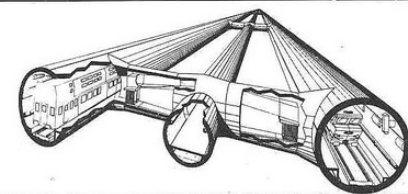
the stones, and when he needed to regain the surface he pulled on his life-line, discarded the satchel and was lifted upwards. He made hundreds of descents in this fashion, and often reached depths in excess of 30 metres.

Quite early in his investigations he decided that a tunnel might not be the most practical solution, and he suggested a causeway linking Dover with Cap Blanc Nez. Next he thought of a massive bridge between Dover and Calais, but the weather conditions in the Channel put him off the idea. Another inspiration of de Gamond's was a giant raft-like vessel driven by huge paddles.

The idea of a tunnel, however, has always been uppermost in people's minds. And now, after many false starts, a plan has been put forward which stands a fair chance of becoming reality.

British Rail and French Railways have jointly come up with a proposal for a £765 million tunnel linking Holy Well (near Folkestone) with Beussingue (near Calais) in France. They aim to build a six-metre-wide railway tunnel to accommodate a single track, with a smaller service tunnel running parallel to it, and linked to it by cross passages.

The tunnels would be bored through chalk beneath the seabed, and lined with prefabricated concrete segments. If it is ever completed, this plan will enable a through train service between London and Paris in a time of only four-and-a-half hours. The tunnelling operation, however, would take somewhat longer to carry out — around ten years!



This ambitious design for a two-track rail tunnel, with a central service tunnel, was eventually abandoned.

THE end of last summer also saw the end of a unique form of passenger travel across the Channel — the train ferry. Until then, it had been possible to board a train at Victoria Station in London in the evening, go to bed and wake up the next morning in the Gare du Nord in Paris, all without leaving the carriage.

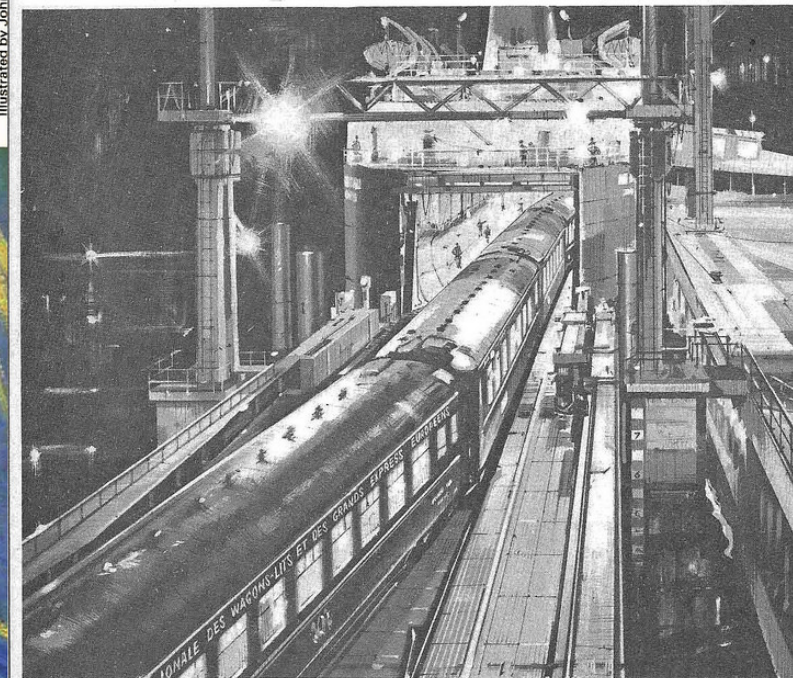
The system was inaugurated in 1936, as the clouds of war were beginning

to gather over Europe. A fleet of specially commissioned sleeping cars, all first class, were put into service over the route. The cars were drawn by a British locomotive to Dover, where they were shunted onto a ferry with track laid inside it. The ferry then conveyed the train to the port of Dunkirk, where the carriages were shunted out and attached to a French locomotive for the journey to Paris.

All this was made possible by the fact that British and French trains ran — and still run — on the same gauge of track. However, although the track gauge is identical, the loading gauge, signifying the width and height of the rolling stock, is not. Accordingly, to let the train pass through our tunnels, the sleeping cars were built to the smaller of the two loading gauges, the British one.

The service was always relatively expensive, and in its time it carried the élite of Europe. Queen Elizabeth used it for her first trip to the Continent, and Sir Winston Churchill often travelled on the train. Once, needing to go to Paris from his country home in Kent, the British Prime Minister had the train specially stopped at Sevenoaks so that he could board it there. It is said that Sevenoaks Station had to be completely closed to regular traffic to enable Sir Winston to make his unscheduled connection. In 1957 an extra carriage was attached to enable a regular through service from London to Brussels to be inaugurated, but already competition from aircraft was beginning to make its mark. By the end of the 1970s, with air travel a mass enterprise instead of the novelty which once it had been, demand for the night train ferry was easing off noticeably. In addition, the rolling stock was showing its age; the investment needed to modernise it was enormous.

Finally, in 1980, SNCF, the French rail organisation, and British Rail, decided that the passenger service was no longer economical, and the last crossing was made. But the ferry with the track laid inside it still runs, carrying freight cars from Europe to Britain. Passengers, however, had had their last chance to experience this form of travel to the Continent.



Loading the night train onto the ferry at Dover.

To Get To The Other Side

A new series that looks at different ways of crossing the Channel

SEE PAGE 18



TO GET TO THE OTHER SIDE

This week we start a new series about the services that span the Channel and link Britain with the Continent—and we start with one of the most modern, the hovercraft.

On Course For Calais

Hovercraft now carry around 6 million passengers and 1 million cars across the Channel on a cushion of air. Services by hovercraft began in 1965 with Seaspeed using SRN4 Mk. 1 machines. The craft illustrated below is a 200-ton SRN Mk. 2, one of four operated by Hoverlloyd. In calm seas it can "fly" at speeds of up to 65 knots.



FOR centuries the only way across the Channel was by boat. Then came hot-air and gas-filled balloons and the aeroplane. But in 1955 an ambitious engineer called Christopher (later Sir Christopher) Cockerell patented a new invention which was eventually to transform passenger transport between Britain and Europe—the hovercraft.

Just over ten years later a Swedish company, Hoverlloyd, began trial runs between the Kent town of Ramsgate and Calais on the French coast. Before long British Rail became interested, too, and by the end of 1969 both organisations were running a full-scale service, BR operating under the name of Seaspeed.

Hover-Harbours

Soon plans were in hand for special "hoverports" at Calais, Dover and at Hoverlloyd's choice, Pegwell Bay. Pegwell is a broad, shallow bay on the Kent coast just below Ramsgate. Once Vikings landed their longships there—indeed there is a replica of a longship on the cliffs above the bay—but before the hovercraft came, Pegwell's only claim to fame lay in the particularly fine lugworms which live in its sands and which are eagerly sought after by local fishermen.

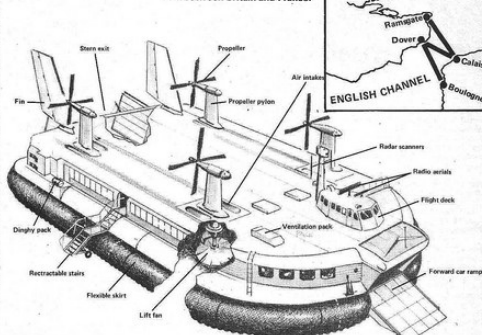
Now the modern terminal which has been built on the edge of the bay has put Pegwell well and truly on the map for the millions of travellers who have used it as their stepping stone to the Continent. Inside the terminal, the departures are announced as "flights", not as sailings; which is only right, since hovercraft really do fly, even if it is only just above the waves.

When the hovercraft is fully loaded, it rises up on its "skin" and sweeps across the concrete, over the sand and soon is skimming over the waters of the bay, out to the open sea.

The English Channel, however, is no empty stretch of water. It has a vast amount of traffic using its sea lanes. And so, in addition to having all the technical ability to fly the hovercraft, the captains must all have qualified as Master Mariners.

Forty minutes after take-off, the hovercraft slides smoothly out of the sea and onto the landing-pad at Calais. The cars are soon rolling down the stern exit ramp, passing through the formality of French customs control... and away they drive.

Hovercraft now provide a fast link between Britain and France.



The SRN4 Mk.2 hovercraft, with an overall length of 40 metres, can carry up to 280 passengers and 37 cars. Some 13,600 ships from the four Rolls-Royce engines speed the 203-tonne craft across the Channel at up to 65 knots—fast cruising even on a motorway. Below: waiting to load. Right: cars enter by forward ramp.



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HOW IT BEGAN

THE FIRST IN
A NEW SERIES
STARTS INSIDE



EXPLORING SPACE

Part three of this special

Speed & Power series

ON THE TAIL OF HALLEY'S COMET

Among the exciting space projects for the future is a plan to send a space vehicle to chase Halley's Comet through the sky and to shoot a mass of scientific instruments into its gaseous tail

STREAMING through the sky on its vast orbit around the Sun goes Halley's famous comet, its long luminous tail curving behind it far into infinity.

Composed of gases and meteoric bodies swirling and racing in space, this comet has intrigued astronomers since Edmund Halley discovered it in 1682 and computed its orbit.

Now the Americans are hoping to take a closer look at it in a really startling way. They are planning to chase it through the skies with a remarkable new kind of space vehicle called a solar sailing satellite.

This will be a vehicle fitted with vast sails made of a special aluminium alloy. They will be 2,300 ft (700 metres) square and capable of carrying a 1,650 lb. (750 kg.) payload of scientific instruments.

The sail will work on the principle that radiation from the Sun can have a thrusting effect, especially on vehicles that have large, light-weight surfaces and are highly reflective.

It is possible to determine the force of the thrust and use it to drive a vehicle in the same way that the wind powers a sailing ship.

The pursuit of Halley's comet is not expected to begin until the 1980s. At the start, the "solar sailer" would tack

towards the Sun, like a yacht sailing against the wind.

Once it had got to within 0.3 of an astronomical unit of the Sun (an astronomical unit is about 150 million kilometres — the Earth's mean distance from the Sun), the intense solar wind pressure would be used to send the solar sailer off on a trajectory that would match that of the comet.

Its force would propel the "sailer" outwards from the Sun towards a meeting with the comet in March, 1986, about a month after the comet had passed its perihelion, at which it is at its closest to the Sun.

However, the "sailer" will not be able to get close to the comet. Instead, it will fly with it in formation, and then send a payload — in effect, a vehicle carrying

Astronaut-engineers look like white ants on the edge of a sheet as they assemble the first solar sail, to be lifted in sections into orbit by the space shuttle. Later sails would be designed to spread themselves automatically. The man in the foreground is wearing a manoeuvring unit.

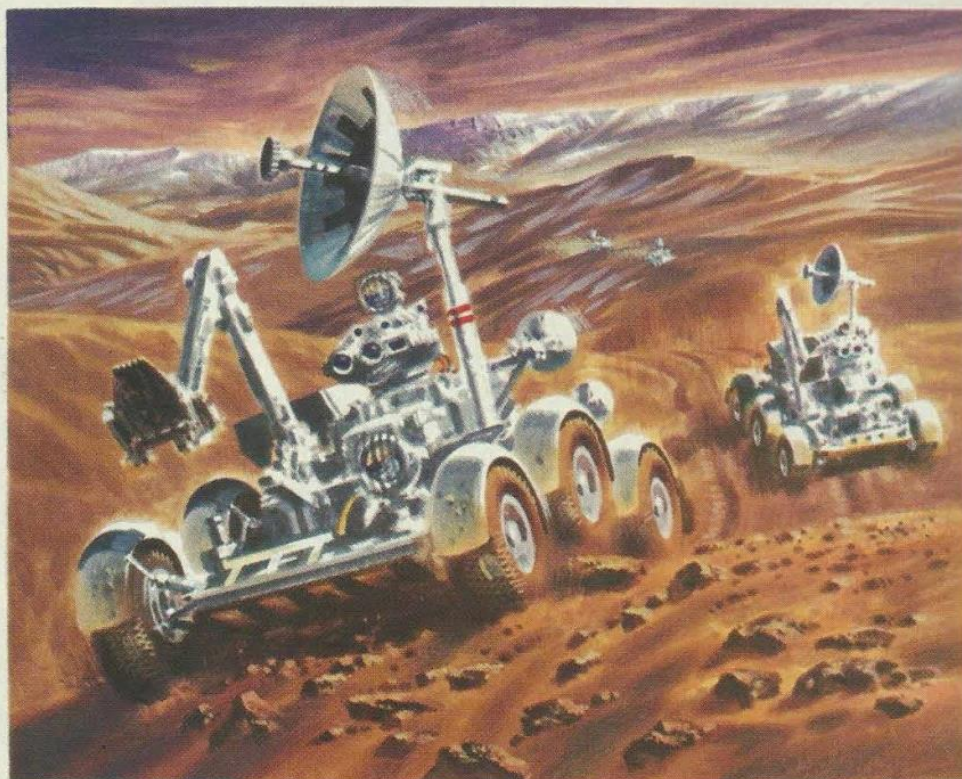
CONTINUED ON PAGE 22





DIGGING UP MARS

A plan to send a spacecraft with roving vehicles to bring back samples from Mars is being planned by the Americans. Follow the above pictures from the bottom clockwise to see how this would be done: Rovers load the return vehicle with samples. Return vehicle blasts off into Mars orbit. It docks with solar sail. Returning to Earth, the sail is met by a space shuttle containing scientists who analyse the samples.



MECHANICAL MARTIAN EXPLORERS

Two pairs of unmanned rover vehicles would make an extended exploration of Mars, if America's plans mature. Working together, they would be operated from Earth through a relay satellite in synchronous orbit over Mars. A solar sail interplanetary shuttle vehicle could be used to bring a large sample of the Martian surface to Earth orbit, where it would be analysed by a scientific team working from the space shuttle. Later, Martian samples may be brought to Earth.

ASTEROID TOUR

Designed with the idea of obtaining clues to planetary evolution is a tour of the asteroids, which are small planets revolving around the sun. A solar sailer packed with scientific instruments and cameras would register the strength of the magnetic forces, analyse the spectrum and measure the size of the asteroids. The asteroid belt beyond Mars consists of millions of pieces of space debris, the largest being Ceres.



SOLAR SAILING SHIP

One of the most startling ideas in space travel is the solar sail, which would use the forces of the sun's radiation to "blow" the craft through the void of space like wind blowing a yacht. It may be used to explore Halley's comet. It is shown here flying in formation with the comet and firing two probes into its tail. A comet's tail always points away from the Sun. It streams out, blown by the same solar wind that drives the solar sail across space, an unlimited power source of the future.

scientific instruments — through the gaseous tail.

Instruments aboard the payload will probably analyse the tail's constituents, measure its temperature and make other findings.

Other missions just as exciting are being planned by the Americans. One of these involves a trip to Mars in 1981 or 1984 by Viking-type space craft which would carry rovers and return with samples of the Martian surface.

Two Vikings would head for Mars carrying their rovers in shells able to withstand the atmosphere of Mars as they shot towards its surface. Once they had emerged from their shells, the rovers — or Mars cars — could be sent out across the terrain.

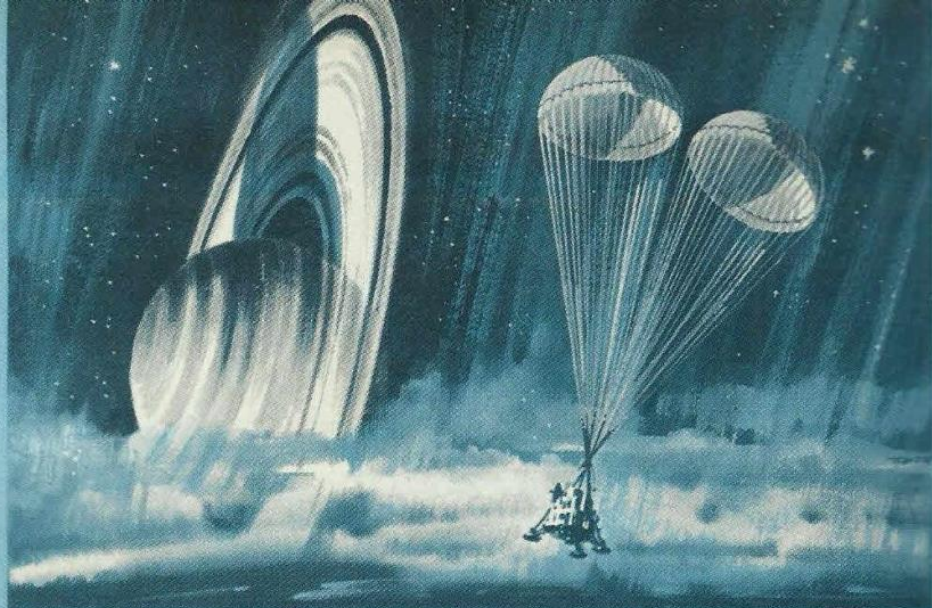
Controlled from Earth — for the flight would be unmanned — these rovers would be fitted with arms for picking up samples from the surface. Lights would be carried for illuminating the craters so that the TV cameras on the rovers could "see" clearly and transmit good pictures back to Earth.

These, and the data gathered by the rovers' instruments, would be transmitted to a space craft in synchronous orbit around Mars, and relayed by this to Earth.

Eventually it is hoped to bring samples of Mars back to a laboratory in Earth-orbit. Rocks and dust would be loaded into a canister, and blasted off from the surface in a retrieval vehicle. This would rendezvous with a "solar sailer" which would bring it to a skylab orbiting Earth.

Also projected for the future is the mapping of Venus by radar. A space craft would be put in a polar orbit around the planet. Radar beams would flood Venus and make a highly detailed map of the planet, radioing this back to Earth.

Other space plans are for an unman-



Scientists are interested in Titan, largest of Saturn's ten moons, because its atmosphere is now shown to be much more like that of Earth's than was previously thought. Its temperatures may be high enough to support organic life. Here, a lander vehicle descends gently, aided by the moon's thick methane-rich atmosphere and its low mass.

ned landing on Titan, a large satellite of Saturn. Little is known about Titan, but this mission should remedy that.

Titan is known to have an atmosphere estimated to be 20-100 per cent as dense as Earth's. This is thought to be rich in methane, and if this is so it could contain a variety of organic molecules, an aspect the scientists would like to know more about.

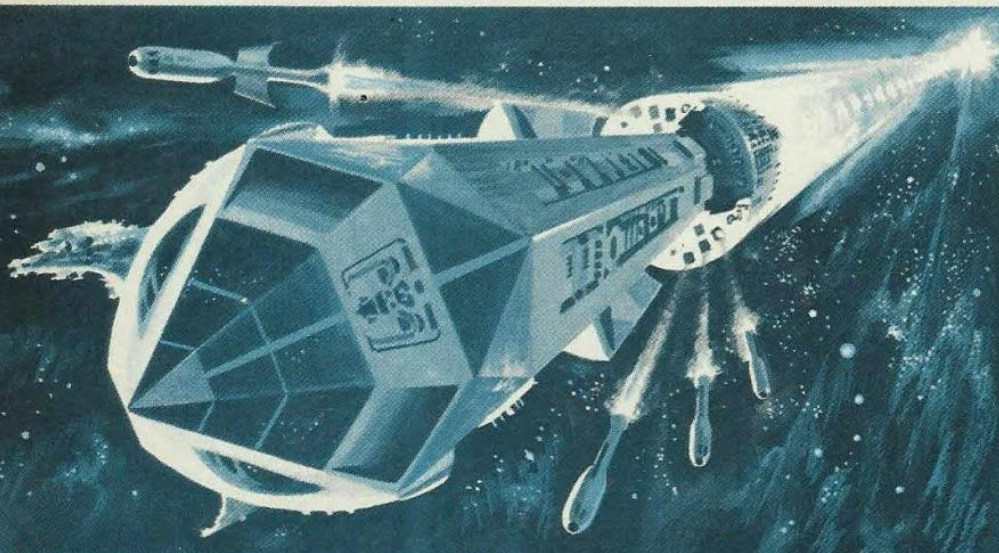
To get to Titan, a dual orbiter-lander would set off for Saturn in about 1985 and go into a circular orbit around Saturn. Once it was circling the planet at a distance about equal to the orbit of Titan, the orbiter would detach the lander and send it down to the surface of Titan. After conducting a variety of experiments, the lander would transmit data concerning these to the orbiter, which would relay them to Earth.

A study of the four major satellites

around Jupiter is also hoped for. The space craft would arrive at Jupiter in April, 1985 and go into an orbit around it before aiming its lander at the satellite, Ganymede. Instruments on the lander would have a direct radio link with Earth. Scientists hope that this mission will tell them what forces were involved in the formation of the planets, because these satellites are like smaller copies of the planets.

Also in project is an asteroid tour. Asteroids are small planets revolving around the Sun, mainly between the orbits of Mars and Jupiter.

Add to this a station on the Moon manned by scientists in the mid-1980s, and you can see that, far from being in the doldrums, the American space programme is lively and kicking and is taking a very active look at a fascinating and exciting future.



The most advanced robot explorers would be true "starships", designed to leave the solar system and reach the nearest stars. They would travel at incredible speeds in order to arrive at their destinations within the lifetime of the scientists and engineers who launched them. Much work has already been done on the propulsion and computer systems for these craft. They would "think" for themselves, navigate themselves and carry out their own repairs under the watchful eye of their "brain" or master computer. Barnard's star is one of the projected targets for a starship — a 50 year flight. Here we see the ship launching its mini-probes to spread out, explore and report on the star's planets.



The speed of the starship would ensure that the men who had constructed and launched it would still be alive 50 or so years later when it began to beam back its findings and those of the probes. So the careers of these fortunate scientists, (who would keep a watchful eye on its mission during its progress, combined with other work) would be crowned by the sight of colour pictures and information from the planets of another star.

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STARS OF THE 'INDY'

SEE INSIDE



THE LIVING SEA

FISH LIKE FLOWERS

Strange animals that look like exotic flowers are among the wonders to be found sharing the ocean depths with fishes which glow with colour

THERE'S an old story of the farmer who went to the zoo and saw a giraffe for the first time. After gazing at it in astonishment for a while, he finally said: "I don't believe it! There isn't such a creature!"

And of course, it is not all that long ago that people in the west refused to believe in the existence of an animal described as having an extremely long nose, ears like wings, and legs like tree trunks. But then they had never seen an elephant.

The world is full of animals of weird shapes, but

nowhere on its surface are there creatures so odd-looking as those to be found under the sea. In the lower depths are fish that almost defy description (we shall be depicting some of these later); but it is not necessary to plunge into the deepest parts of the oceans to find marvels of shape, patterns — and behaviour.

Take the huge family of worms, for instance. Some have brilliant colours; others have false legs on their bodies which give them the appearance of centipedes; some light up at



night like little green, blue and red stars. There is one type round our shores which is several yards long but has a body about the thickness of thin string.

Some of them catch their food with a poisonous sting; others live in home-made tubes of sand or mud, sticking their flower-like heads out to obtain food and vanishing into the tube when disturbed.

One species which provided a real puzzle for the zoologist is the palolo worm

KEY

1. Spirographis.
2. Plumrose anemone.
3. Beadlet anemone.
4. Skate.
5. Grouper.
6. Goose barnacles.
7. Giant green anemone.
8. Hermit crab.
9. Beadlet anemone.
10. Palolo worm.
11. Furbelows.

CONTINUED ON NEXT PAGE▶

PUTTING THE SUN TO WORK



BECAUSE mankind realises that its traditional sources

of energy, such as coal, oil and natural gas, will be approaching exhaustion in the not too distant future, he knows he will have to find alternative sources of power to keep his machines running, and indeed, just to keep himself warm in winter, if he is to survive to the end of the 21st century and beyond.

One of the obvious sources of energy that scientists have been examining seriously over the last decade is the Sun, which, in a sense, is really the prime

Sunshine beating mercilessly upon barren deserts may soon be made to supply a vital human need

source of all energy man has consumed since he learned how to light a fire, how to operate a steam engine or an internal combustion engine, how to generate electricity, and so on.

A number of methods of harnessing the tremendous, and almost inexhaustible, energy of the Sun have been tried, and it is likely that some of these methods will be put into practice by the end of the present century.

Ideas like the use of solar panels for generating electricity, and perhaps the more widespread use of giant solar furnaces like the one built by French scientists, will one day be brought into general use.

Although sun-power is free for everyone to use, the task of converting it into other usable forms of energy is a tremendous undertaking, both technically and financially. But man is an

inventive animal and, so far, when his very existence has been threatened, he has usually come up with a solution that has enabled him to survive.

Now, scientists in the United States of America have produced a new solar power plan which they hope will be both a simple and an economic way of producing electrical energy. At a place called Boardman in a sun-drenched area of the state of Oregon, they are building a field of experimental solar reflectors called 'Heliostats'.

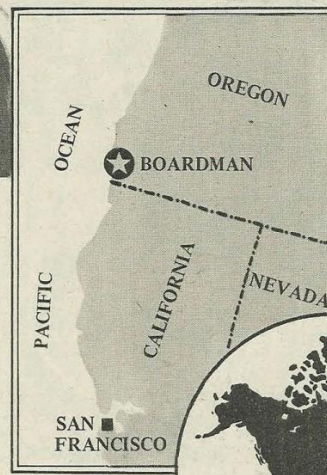
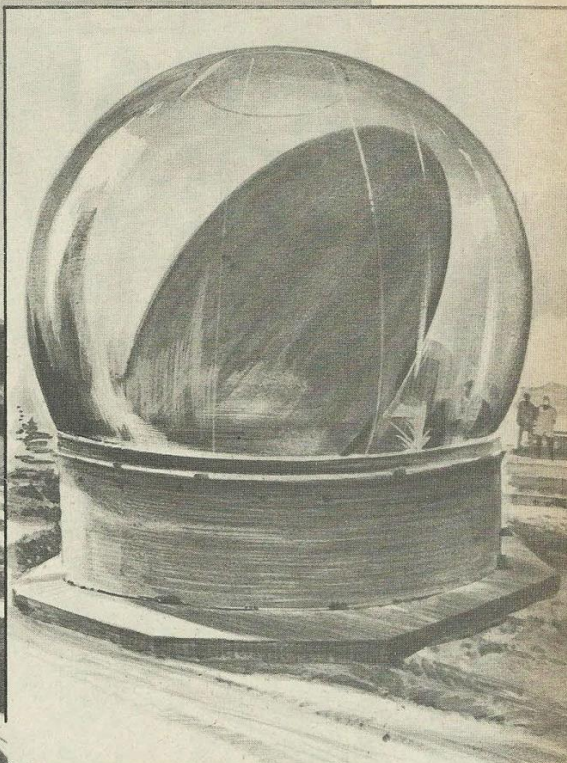
During 1976, the Boeing Engineering and Construc-

tion Company will complete the building of a number of polished parabolic mirrors which will direct the Sun's rays into a laboratory on top of an old rocket tower, where special instruments will measure the energy received at different times of the day, and under varying conditions.

Each mirror will be enclosed in a transparent plastic dome to protect it from the weather. The devices are designed to withstand winds of up to 80 mph with gusts of up to 100 mph, but the Boeing scientists want to find out the effects of other aspects of

the harsh desert environment, such as the erosive effects of sandstorms, damage from wind-blown clumps of tumbleweed, and also the long-term effects of exposure to the Sun.

If the results of the experiment are favourable it is possible that a full scale heliostat energy plant will be constructed, with hundreds of the dome-enclosed mirrors computer-controlled so that each one follows the Sun's path across the sky. The heat from the reflected beams would heat a working fluid which, in turn, would drive electric turbo-generators.



Plastic mirrors encased in transparent domes are envisaged as a means of producing electrical power. They would direct the Sun's rays onto a central tower, where they would heat a fluid which would drive a turbine. Computers would cause the mirrors to be constantly turned towards the sun.

Boardman in Oregon, U.S.A. (see map) is the setting for the solar experiments which it is hoped will provide the world with a much-needed new source of power.

40 PAGES OF ACTION-PACKED FACT AND FICTION

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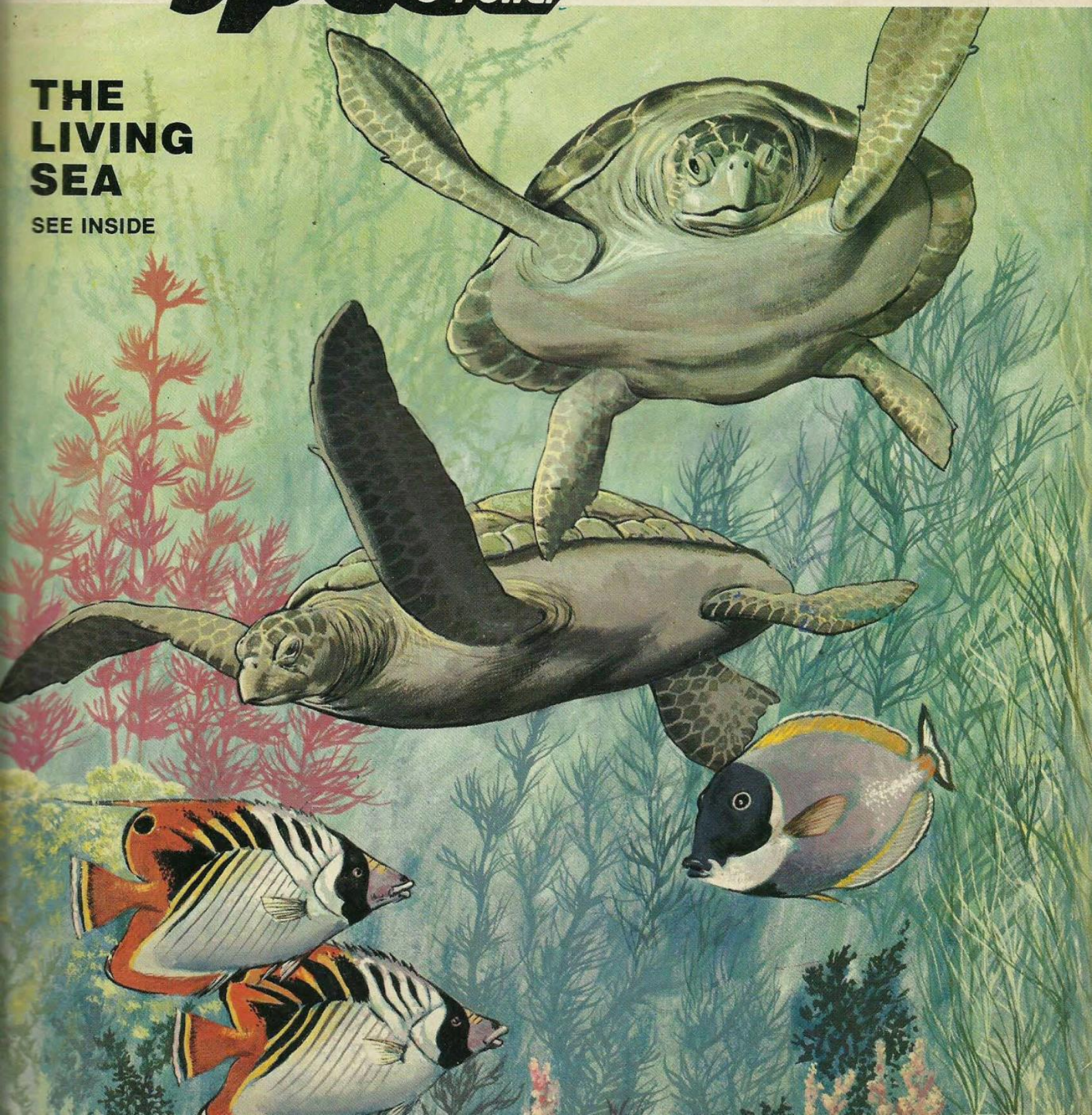
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THE LIVING SEA

SEE INSIDE





THE LIVING SEA

TENTACLES OF TERROR

A touch from the dangling tentacles of a jellyfish means death to the small inhabitants of the oceans, for these are charged with a powerful poison

KEY

1. Portuguese man-of-war.
2. Damselfish.
3. Sea horses.
4. Tuskfish.
5. Porcupine fish, inflated.
6. Turtle.
7. Tuskfish.
8. Scallop.
9. Polyps of a coral.
10. Clown fish.



THE pale jellyfish, the rock-like corals, the sea anemones that look like beautiful flowers and the sea fans with their delicate lacework, seem to have little in common. Yet they all belong to the same family.

The connection is that all these animals have a large stomach which occupies most of the body, and a mouth-like opening at one end fringed with tentacles.

On a warm, clear day the delicately-tinted jellyfish can be seen just under the surface of the water, gracefully swimming with rhythmic movements — a sort of animated umbrella. So light and fragile are they, that

CONTINUED ON NEXT PAGE ►

SCIENCE SURVEY

ELECTRONIC SHOPPING



JAPAN has opened the world's first electronic supermarket in the suburbs of Tokyo. It sells all the things normally available in supermarkets, but its goods are locked inside transparent containers.

A customer is issued with a small plastic card. To make a purchase, he slips this into a slot near a container and presses a button. At this a computer takes over. It "reads" the card, opens a door to release the purchase, and records the sale.

When the customer has finished shopping, he takes his goods and his card to a check-out counter. The cashier puts the card into a cash register linked to the computer. This tots up the total cost of the goods and prints it on a sales slip and shows it on the register in less than a second.

The developers of the system claim that such a supermarket can be run efficiently with much smaller staff than conventional supermarkets need.

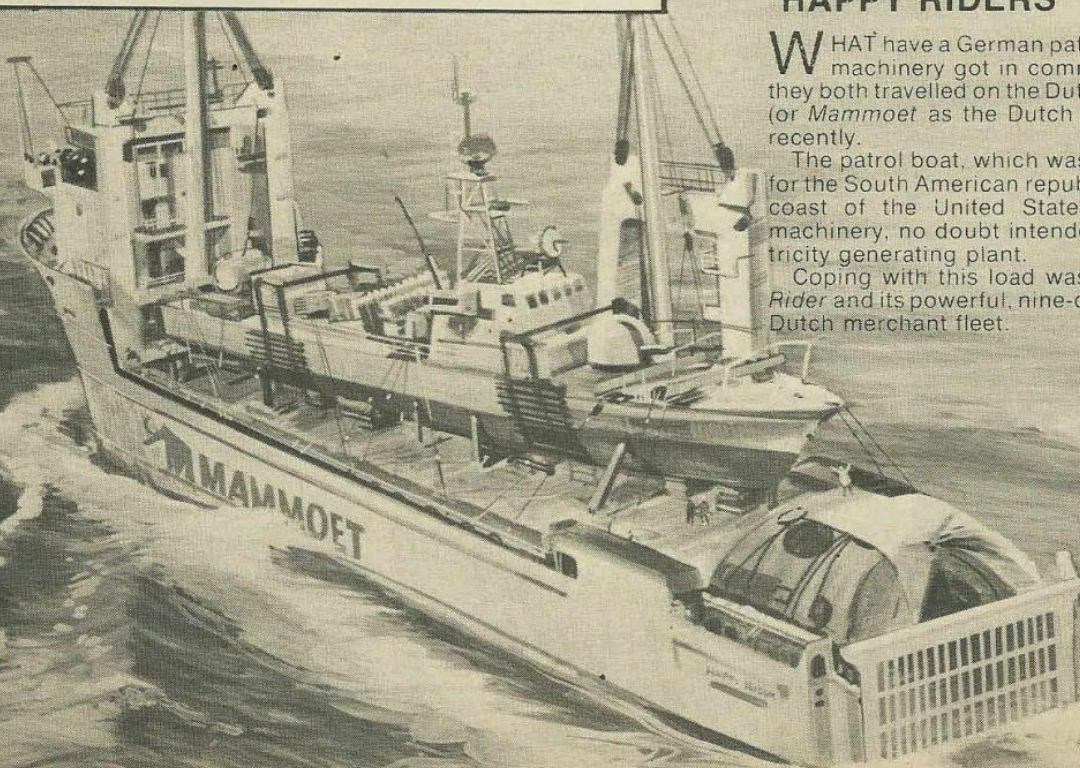
The electronic supermarket also makes shoplifting virtually impossible, as there is no way of getting out of the building without paying. Each plastic card is magnetically linked to the computer even when it is not in use. If anyone tries to slip past the cashier without paying, a warning system sets off a buzzer. And if by any mischance the card does get taken outside the supermarket, it transmits a signal which the police can follow!

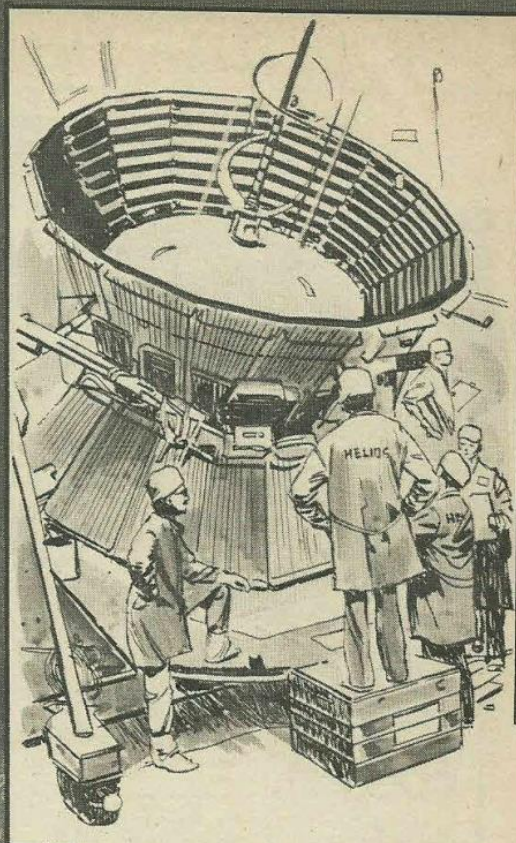
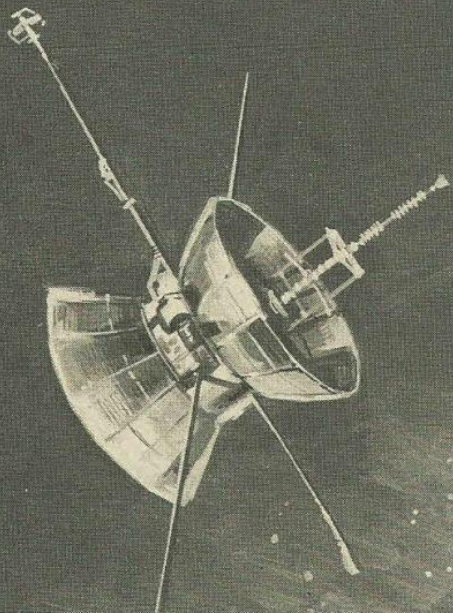
HAPPY RIDERS

WHAT have a German patrol boat and British turbine machinery got in common? Nothing, except that they both travelled on the Dutch cargo ship *Happy Rider* (or *Mammoet* as the Dutch call it) across the Atlantic recently.

The patrol boat, which was of 220 tons, was destined for the South American republic of Ecuador. To the west coast of the United States was going the turbine machinery, no doubt intended to become part of electricity generating plant.

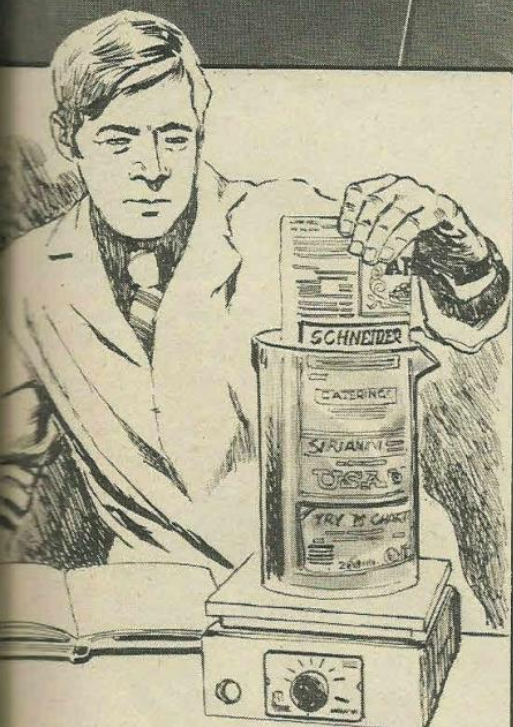
Coping with this load was easy work for the *Happy Rider* and its powerful, nine-cylinder diesels, pride of the Dutch merchant fleet.





FOCUS ON THE SUN

OFF to take a close look at the Sun — as close as it can get without melting — will be the unmanned space craft *Helios*. Due to be launched soon, it is a joint German and American venture. *Helios* Will study the Sun when it is going through a very active spell, radioing its findings back to Earth. Scientists will be able to carry out experiments and make measurements from different orbits from within 0.29 astronomical units (an astronomical unit is about 150 million km). This surpasses a previous probe's 0.31 units.



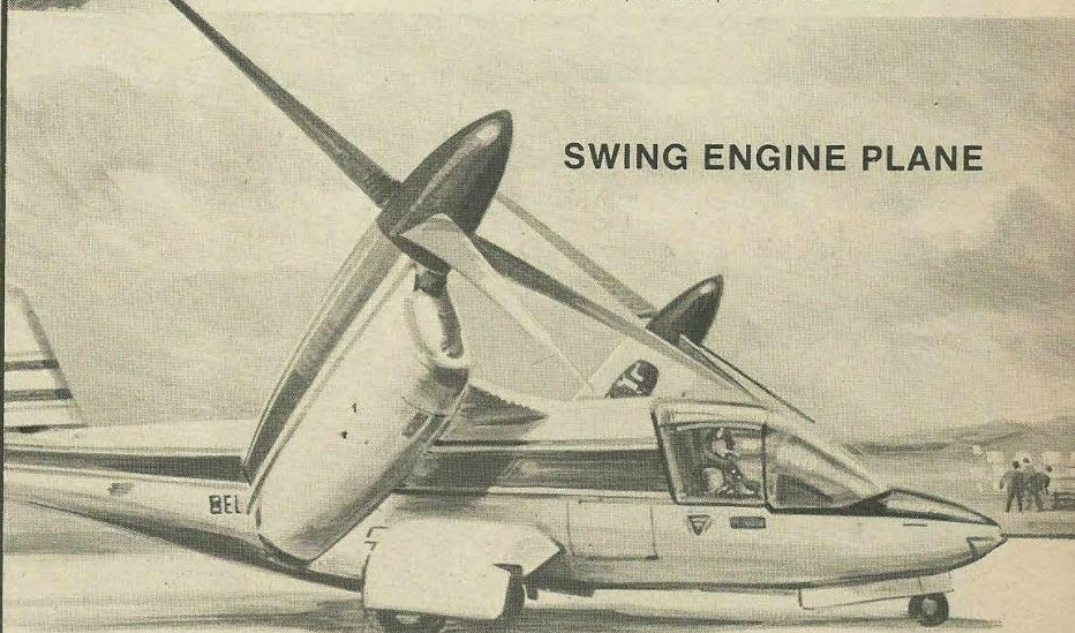
BLEACH SAVES TREES

FIRST it's yellow — and then it's white. That is what happened when the chemist took some sheets from a telephone directory with yellow pages and dipped them in a bleach.

The object was to find a yellow dye that would bleach out easily so that the paper could be re-pulped and made into fresh paper suitable for printing upon.

The success of this experiment will enable the Americans to re-use enough paper to save them felling 950,000 trees a year — a tremendous victory for the tree conservationists.

SWING ENGINE PLANE



NEITHER a helicopter nor a conventional aircraft is a new flyer currently being tested in the States. It's called the Textron XV-15.

What make it revolutionary are the turboshaft engines mounted at the tips of the wings and driving propeller-like rotors. Nothing sensational about that?

Well, the startling thing is that the complete wing-and-engine assemblies can be tilted. This enables the aircraft to take off and land vertically like a helicopter. Yet, it can also fly conventionally at more than 300 mph (over 480 km/hr). This arrangement could be used in civil and military designs of the future.

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HERE COMES THE MAIL

THE STORY OF THE POSTAL SERVICE:
INSIDE



**Speed
& Power**

COMMUTING IN SPACE

America's giant space shuttle will soon be taking men to work 1,000 miles above the Earth's surface.

EVERY time the astronauts in the Apollo space programme went to the Moon, something like £100 million pounds worth of equipment had to be either jettisoned during the flight, or abandoned on the surface of the Moon.

Even a country as rich as the United States realised that future trips into space would have to be carried out in a more economical manner, and before the Apollo Moon flights ended in 1972, they had come up with the Orbiter Shuttle idea.

As its name suggests, the Shuttle is designed to 'commute' from Earth into outer space and back again — if need be in the course of a day's work. Although most Orbiter missions will probably last from a week to 30 days, it would be technically possible to make a trip out and back in a day.

The Orbiter is launched by means of two booster rockets attached to the sides of its huge fuel tank. These rockets are jettisoned when they have done their job of helping to accelerate the

spacecraft to its orbital speed, but they are fitted with parachutes and can be salvaged by ships waiting in the area where it is known they will fall into the sea.

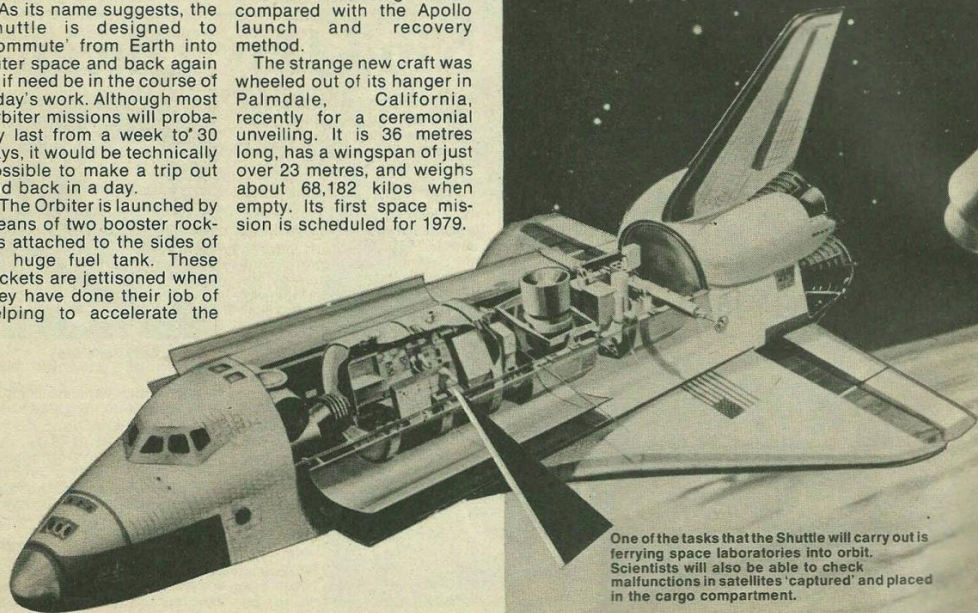
The giant fuel tank is the only part of the Orbiter which will not be used again. The shuttle itself can be piloted back to Earth, and landed like a conventional aircraft.

Scientists believe that this new generation of spacecraft will be capable of making at least 100 trips with only routine maintenance — an enormous saving in costs compared with the Apollo launch and recovery method.

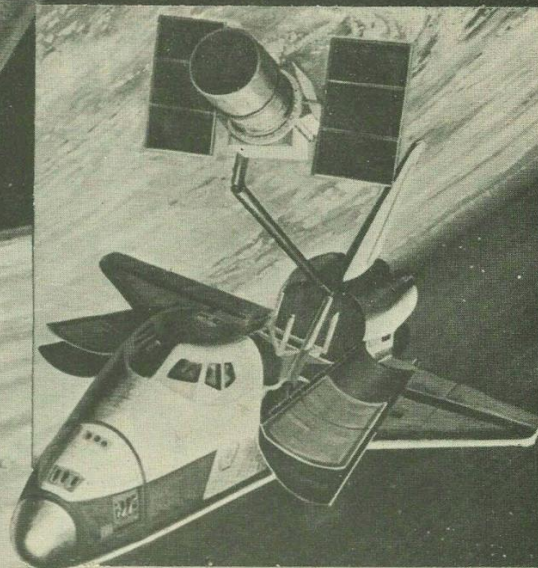
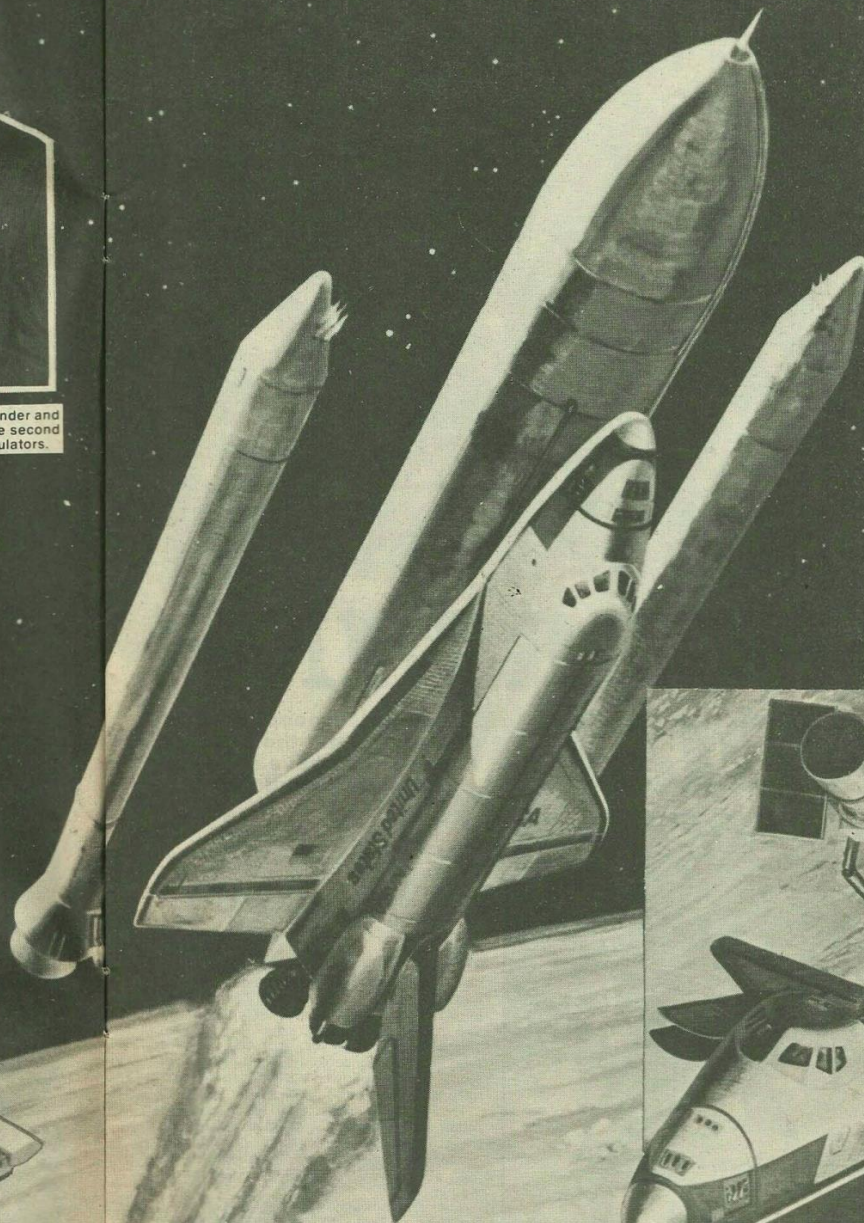
The strange new craft was wheeled out of its hanger in Palmdale, California, recently for a ceremonial unveiling. It is 36 metres long, has a wingspan of just over 23 metres, and weighs about 68,182 kilos when empty. Its first space mission is scheduled for 1979.



Orbiter's number one crew is Fred W. Haise (left) the commander and C. Gordon Fullerton, pilot. Together with the members of the second crew, they have been undergoing intensive training in simulators.



One of the tasks that the Shuttle will carry out is ferrying space laboratories into orbit. Scientists will also be able to check malfunctions in satellites 'captured' and placed in the cargo compartment.



The Orbiter's capacious cargo bay could also be used to put space telescopes into orbit. Large space stations could also be ferried into orbit in sections and assembled by astro-engineers

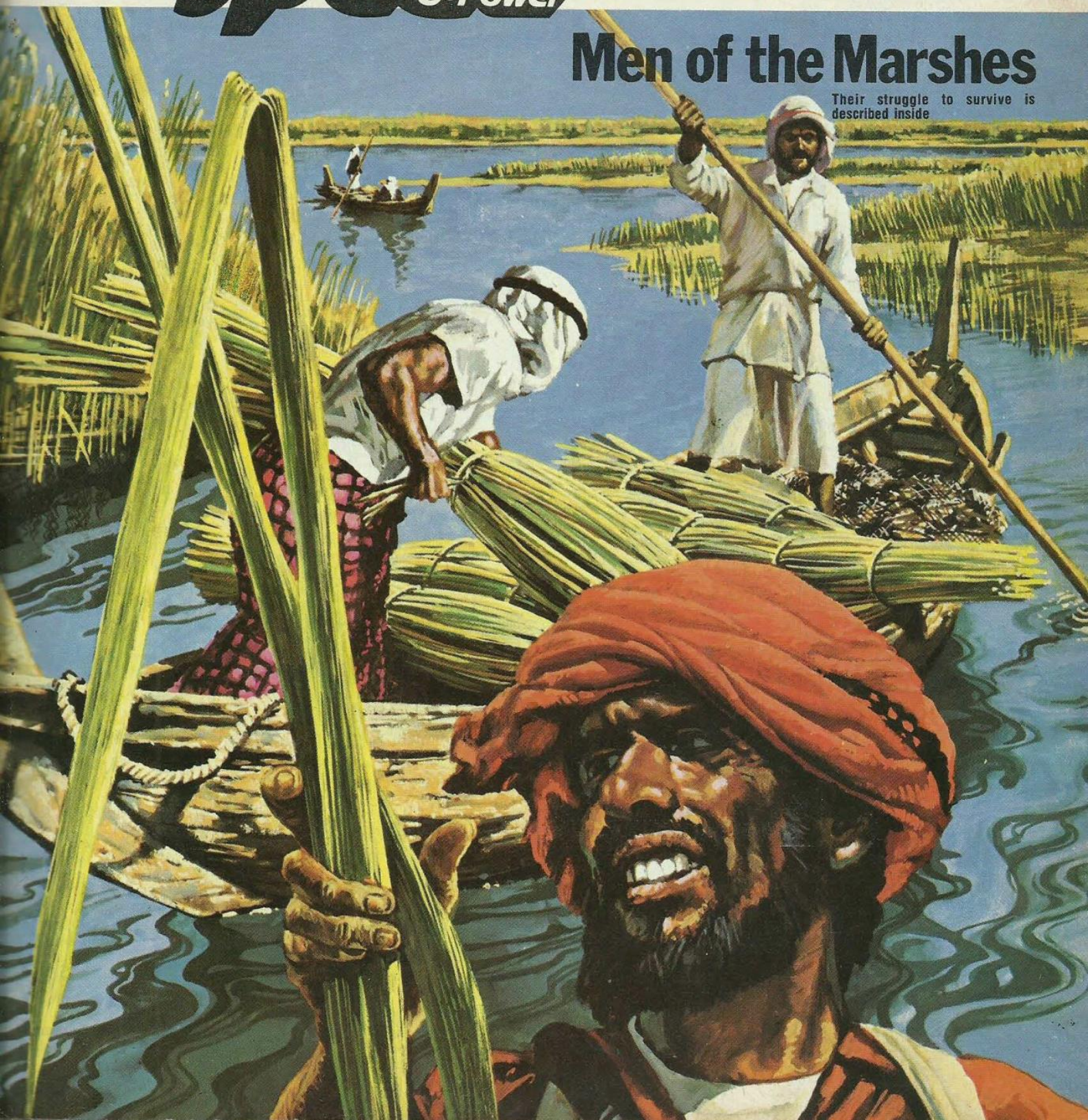
LOOK AND LEARN

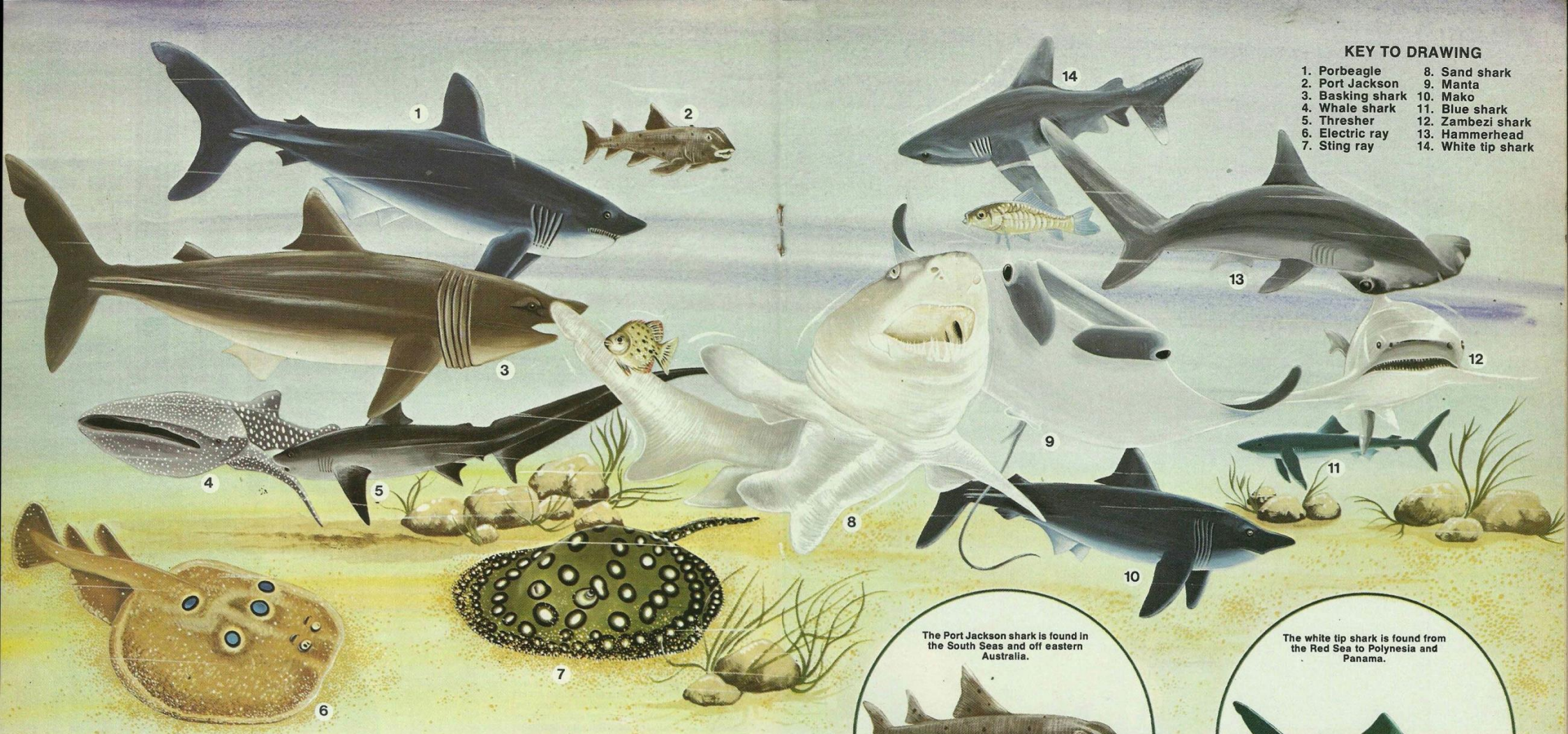
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Men of the Marshes

Their struggle to survive is described inside





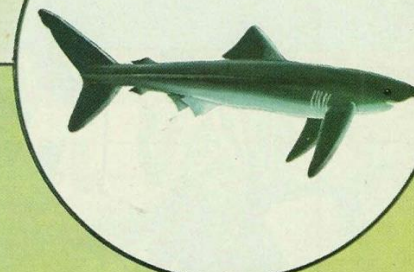
KEY TO DRAWING

- | | |
|------------------|---------------------|
| 1. Porbeagle | 8. Sand shark |
| 2. Port Jackson | 9. Manta |
| 3. Basking shark | 10. Mako |
| 4. Whale shark | 11. Blue shark |
| 5. Thresher | 12. Zambezi shark |
| 6. Electric ray | 13. Hammerhead |
| 7. Sting ray | 14. White tip shark |

The Port Jackson shark is found in the South Seas and off eastern Australia.



The white tip shark is found from the Red Sea to Polynesia and Panama.



THE LIVING SEA

TERRORISTS OF THE DEEP

Long before the film "Jaws" startled millions around the world, sharks instilled fear into mankind. Yet not every species need make bathers beat a rapid retreat from the water

NO creature of the sea has a more terrifying reputation than the shark. Many a story, and more recently the highly successful film *Jaws*, have helped to make the word shark a frightening one. Yet there are several species of shark, including some of the biggest, which offer no threat to human beings. Sharks are normally classed as fish, but they belong to a group having features which clearly distinguish its members from the majority of fish. Most types of fish, like mammals,

have skeletons of bone. But the selachians, the group to which sharks, rays and skates belong, are "cartilaginous". This means that their skeletons are composed of a kind of gristle. In addition, their gills, by means of which they extract oxygen from the water, lack the gill-covers present on other fish. Another feature is that the selachians have to keep in constant motion to keep afloat, as they lack the "swim-bladder" which gives buoyancy to the other types.

A fourth difference is to be seen in the shark's scales. These

are constructed like minute teeth, and instead of overlapping they are joined by leathery skin. Finally, all the sharks breed their young in a manner rarely found among bony-skeletoned fish. Normally, the female fish lays eggs, which are afterwards fertilised by the male, and in due course hatch out to produce the young. The eggs of selachians — and of a few other species, such as the tropical guppy — are fertilised inside the female. In some cases the fertilised eggs are laid — as with birds or reptiles. The

CONTINUED ON NEXT PAGE ► 21

**Speed
& Power**

ENERGY FROM THE OCEANS

Covering nearly three-quarters of the Earth's surface are enormous storage batteries. These are the oceans which capture the Sun's heat and slowly release it. Scientists are experimenting with ways of turning that heat into electrical energy — without pollution

FOR some years now scientists have been experimenting with different ways of harnessing the energy of the Sun so that it can be used to supplement, and perhaps eventually replace, other sources of energy on the Earth, many of which will become exhausted in the foreseeable future.

So far, most of the sun-energy gathering experiments have been concerned with catching its rays as they strike the Earth, gathering them with some kind of reflector or group of reflectors, and then concentrating them on to a central point where the immense heat can be used to raise the temperature of water, or some other liquid, to boiling point so

that the steam can drive turbo-generators.

This direct method of harnessing the Sun's heat is quite effective, although it would only be really useful in those regions of the world where there is more or less continuous sunshine. Scientists have not overlooked the fact, however, that warmth from the Sun is being absorbed by virtually everything on Earth — and particularly by the oceans, which cover something like three-quarters of its surface.

In certain areas, the surface temperature of the oceans is as high as 80°F (about 27°C), while 800 metres down, the temperature of the water is only 40°F (4.5°C). This difference in temperature can be

regarded as thermal energy, and physicists have calculated roughly that it is equivalent to the power that a high waterfall could supply if it were used to turn a waterwheel.

The secret of how to make use of this almost inexhaustible supply of energy was discovered more than 40 years ago by a French engineer named Georges Claude. Claude designed a system which turned warm seawater into steam by using a vacuum boiler. Those of you who are studying physics at school will probably know that water boils at temperatures lower than the normal 100°C when atmospheric pressure is reduced. Conversely, when atmospheric pressure is

increased above that found at sea level (as in a pressure cooker) water will boil at a higher temperature.

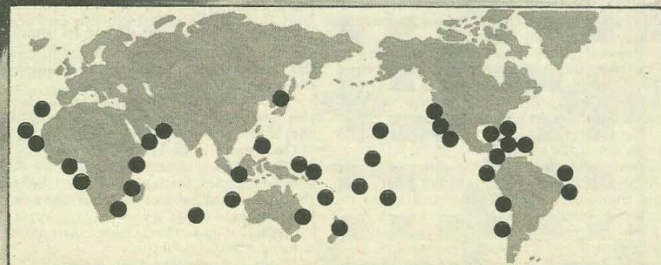
Claude built an experimental power plant at Matanzas Bay in Cuba, and he used cold water from the sea bed to condense the steam from the warmer surface water which boiled inside his vacuum vessel. His trial generator, driven by a steam turbine, produced 22 kilowatts of electric power — not a very large amount perhaps, but it showed the practicability of his idea. Unhappily, a severe tropical storm wrecked the installation, so the experiment never went any further.

During the 1920s, Georges Claude toured the United States trying to raise

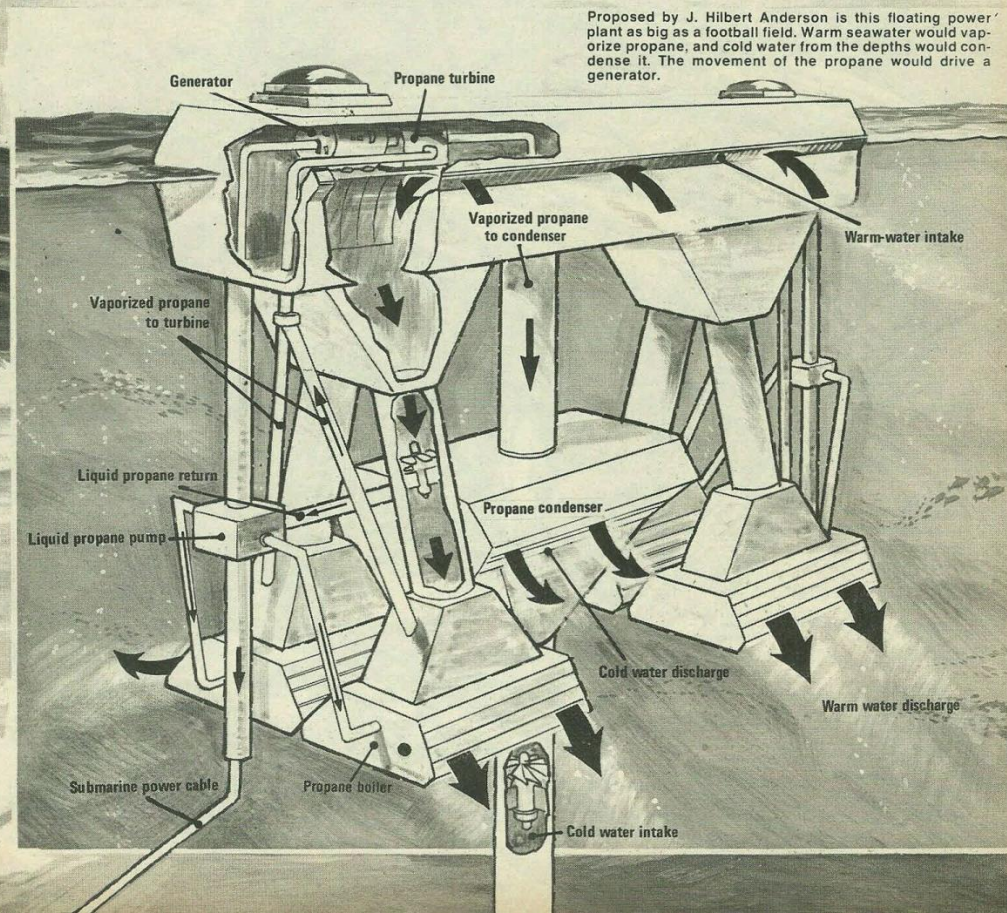
money for his ocean energy project, and his idea made a big impression on a graduate student at Michigan University, where Claude used hot and cold water from ordinary household taps to prove that his vacuum boiler would produce steam. The student was Donald Othmer, who later became Dr. Othmer, a famous professor of chemistry at the New York Polytechnic Institute.

Dr. Othmer never forgot Claude's thermal energy idea, and during the 1960s he was involved with a plan to build a power plant in the warm Caribbean waters which would not only generate electricity, but would also produce salt-free distilled water as a by-product. It

CONTINUED ON NEXT PAGE ►



Indicated by the black areas are regions in which the sea conditions are favourable for harnessing the sea's heat.



Proposed by J. Hilbert Anderson is this floating power plant as big as a football field. Warm seawater would vaporize propane, and cold water from the depths would condense it. The movement of the propane would drive a generator.

was hoped to have a finished power station in operation in 1973, but political changes in Cuba made the Americans cancel the project. Since that time, other countries have shown interest in Dr. Othmer's design, including Japan.

Another American scientist, John Hilbert Anderson, has proposed a different method of using the ocean temperature differences to generate electricity. Anderson's system would actually involve building a floating power station moored well out to sea, which would

deliver its electricity to the mainland through a submarine cable. Dr. Othmer's method consisted of a shore-based power station drawing cool water through a pipeline several miles away at sea.

The Anderson system would also make use of liquid propane gas (similar to that used in portable cooking stoves) instead of seawater, in a boiler working at a lower vacuum pressure than the one used in the Othmer system. Warm water raises the temperature of the liquid propane causing it to

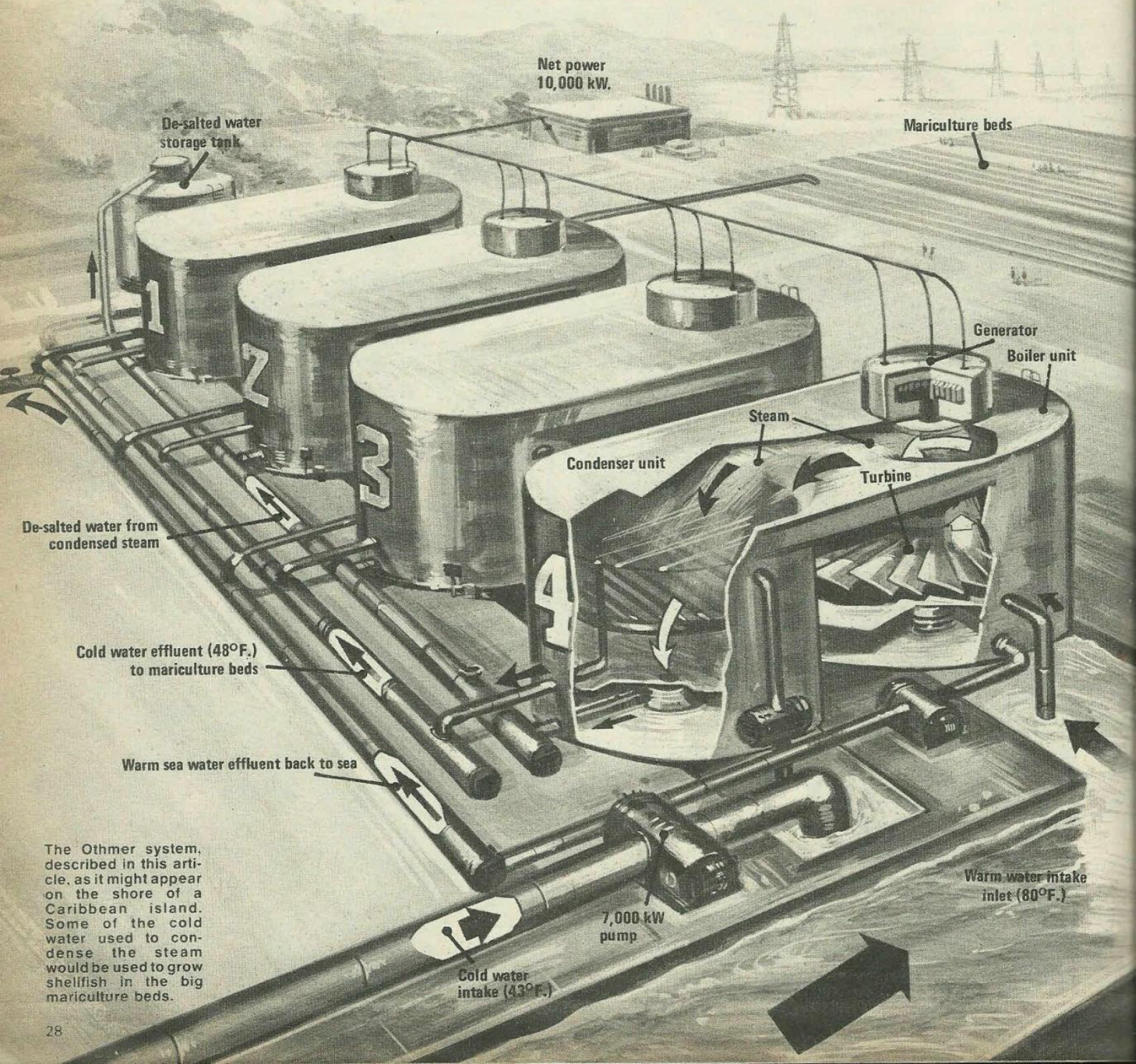
boil and form a gas. Cold seawater is then used to condense the gas after it has passed through the turbine.

The propane boilers would be 90 metres below the surface of the sea, and the condensers about 50 metres down. Cold water would be drawn from a depth of about 650 metres.

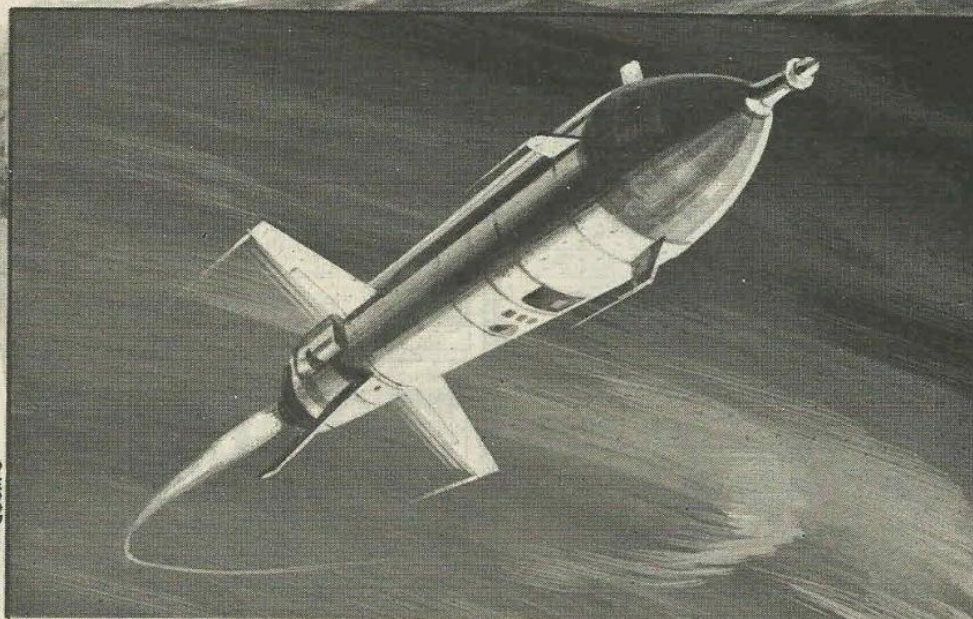
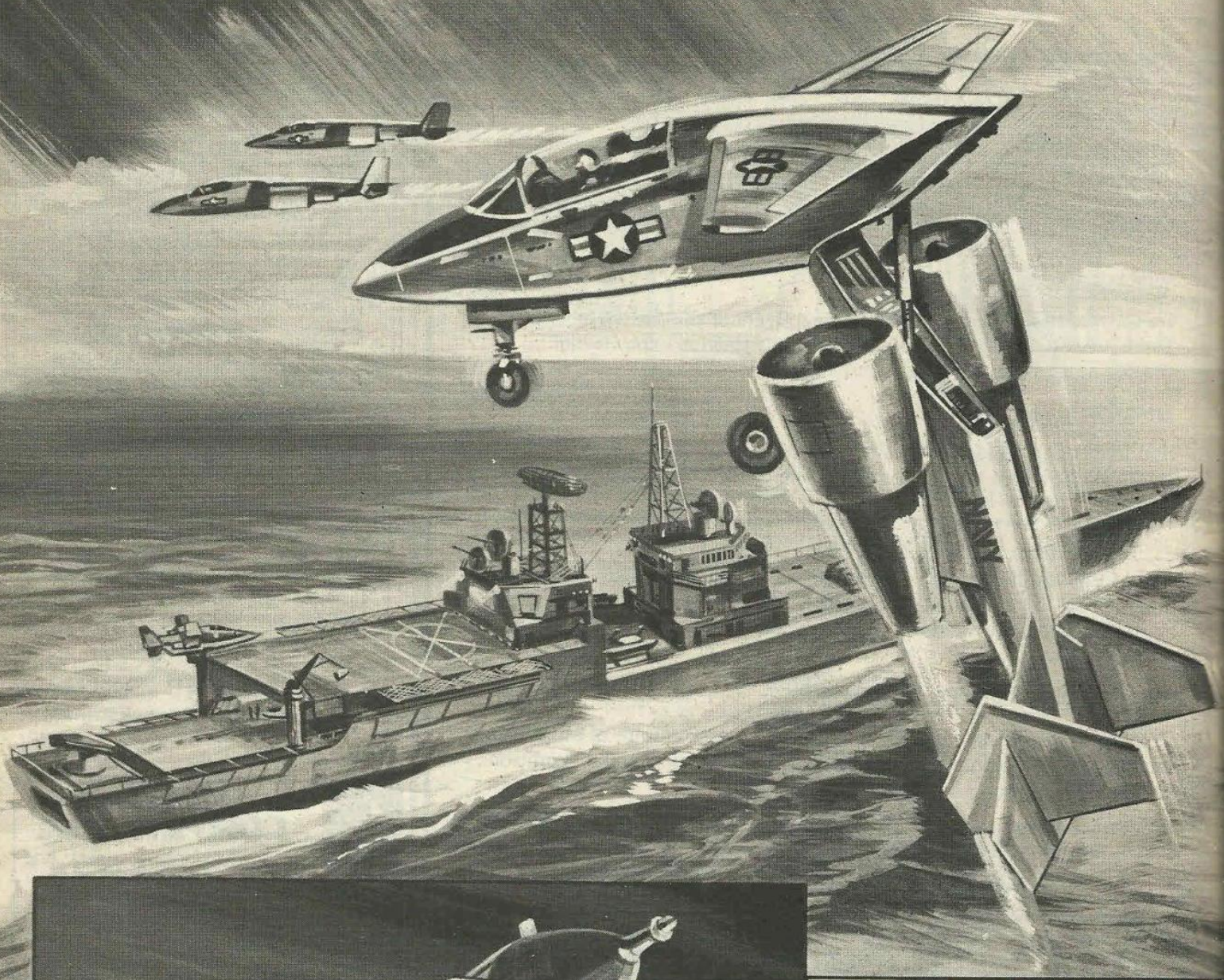
One of the by-products of generating electricity in these ocean power stations could be sea farming, or 'mariculture'. The cold water sucked up from near the seabed contains the nutrients on which large num-

bers of fish thrive. This water need not be simply discharged into the sea after completing its cooling function, but could be pumped into underwater tanks where fish could feed on it.

Although ocean-energy electricity cannot at present be produced as efficiently as conventional coal or oil-fired generating stations can produce it, when these fossil fuels begin to run out they will become more and more expensive, and then the Sun's energy released from the sea will come into its own.



The Othmer system, described in this article, as it might appear on the shore of a Caribbean island. Some of the cold water used to condense the steam would be used to grow shellfish in the big mariculture beds.



SPYING BEHIND THE LINES

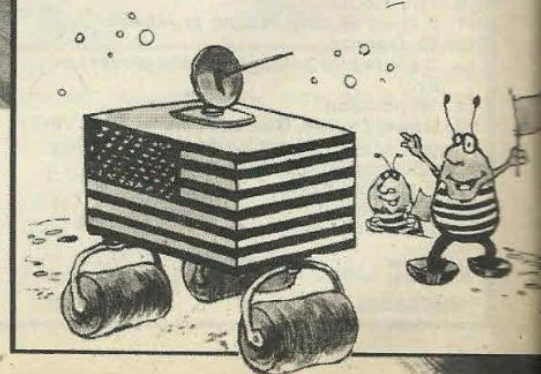
An aerial eye that will observe enemy movements behind the lines is the "drone" above, being developed jointly by Canada and West Germany. Designated the CL-289, it will provide surveillance and reconnaissance information on forward battle areas at greater ranges than previously possible.

With its course and flight path pre-programmed, the drone will fly over enemy territory taking photographs and piercing clouds and darkness with its infra-red eye. All its findings will be relayed back to base by radio. Launched by a rocket booster, the drone will be kept airborne by its small jet engine.

CARS ON MARS

What a surprise the men on Mars — if there are any — will have when a future Viking lander drops out of the sky and begins trundling about on their planet.

This may be possible, because the Americans plan to replace the lander's three landing pads with barrel-shaped flexible wheels. With these, the lander will be able to climb slopes on soft soil, and sharper gradients on a hard surface, to give us a closer look at a distant planet.



SCIENCE SURVEY

A collection of news items on science topics, mainly from across the Atlantic

THE FOLDING FLYER

A strong rival to Britain's jump-jet, which can take off vertically from a ship's deck, could be a new plane still on the drawing boards in the U.S.A.

This is the Nutcracker VTOL (vertical take-off and landing) which would take off like a helicopter with its fuselage bent. Once it was climbing, the plane's fuselage would be straightened, and it would then become a conventional jet ready for its mission.

For its landing, the plane would fold up again, this operation taking about 50 seconds.

SOFT LANDINGS

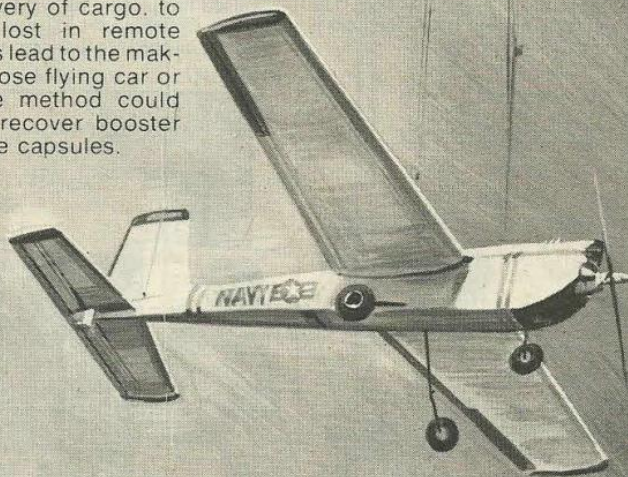
Remotely-controlled planes are being brought safely to earth with the help of a parachute-like flexible wing.

This is released by the plane when it is about to land, and is hooked by a horizontal boom attached to a long vertical one.

For recovery at sea, the booms are carried on a ship, and for land recovery they are attached to a lorry.

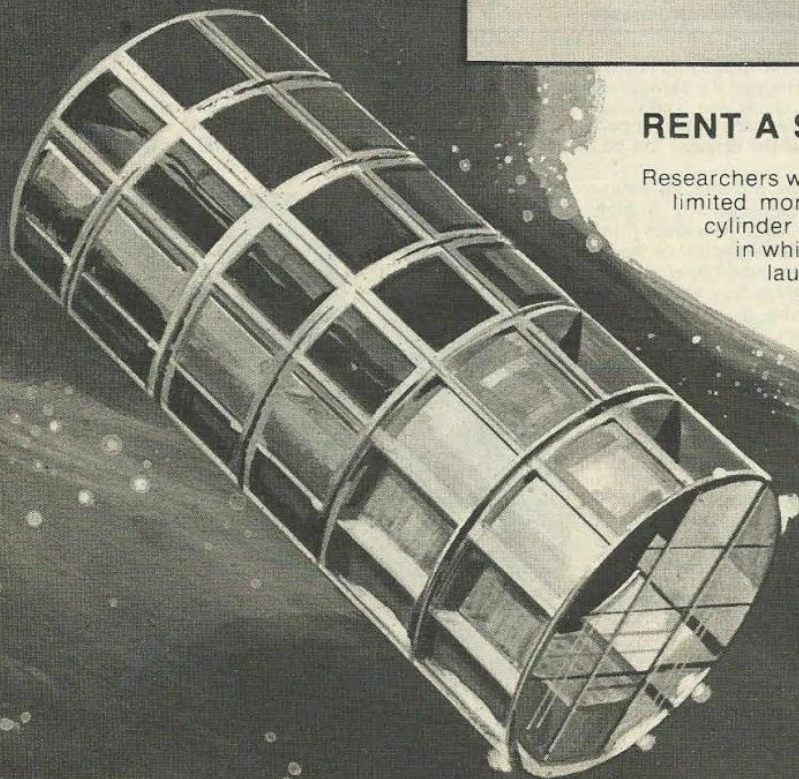
Experiments in the use of such booms and parafoils (as the flexible wings have been called) have been made by students at an American university in California.

They consider that they could be used for the delivery of cargo, to recover people lost in remote areas and perhaps lead to the making of an all-purpose flying car or motor cycle. The method could also be used to recover booster rockets and space capsules.



RENT A SPACE — IN SPACE

Researchers who want to make an experiment in space, but have limited money to spend, will be catered for by the orbiting cylinder shown here. Bolted to the cylinder will be 76 trays in which experiments can be mounted. America hopes to launch the first of these cylinders in 1979. It will be put into orbit by a space shuttle and recovered after from six to nine months. The experiment will then be returned to the clients.



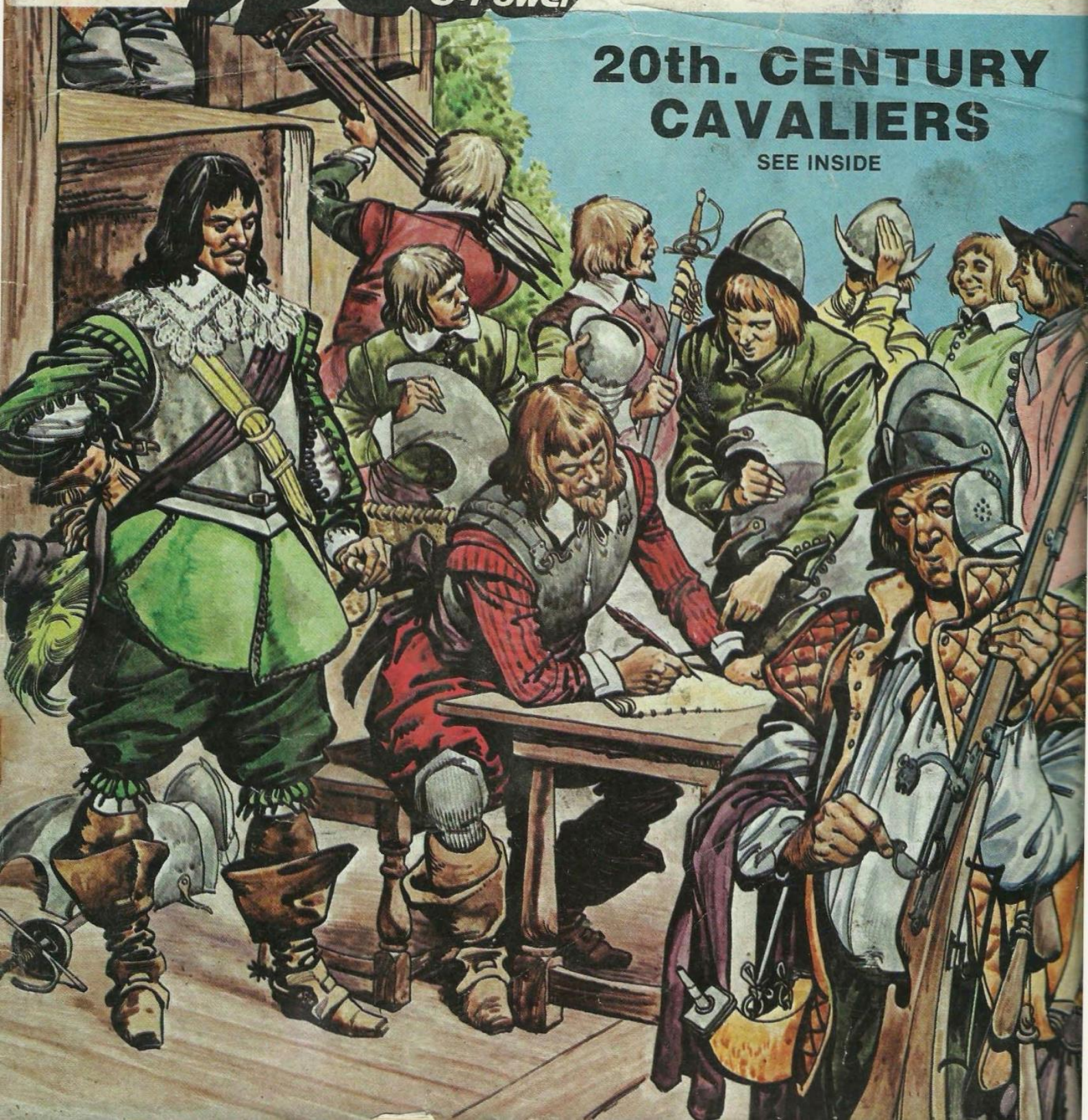
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20th. CENTURY CAVALIERS

SEE INSIDE



THE DESERT RULERS

THE sands of Arabia may be transformed into farmlands by an amazing plan to tow gigantic icebergs wrapped in plastic shrouds from the Antarctic to the desert kingdom of Saudi Arabia.

The idea was born out of Saudi Arabia's chronic water shortage. Already, she has engaged experts in desalination—the process that

changes the sea into drinking water—and several installations have been set up around her shores. Indeed, a British firm, Weir Westgarth of Glasgow, one of the world's main suppliers of desalination plants, is building a plant near the city of Jeddah to provide a vast quantity of water every day.

But desalination is a very

expensive affair, as the Saudi Arabian government discovered. Today, it has earmarked about \$5,000 million during the present financial year for developing plants for its desalination project.

Yet this is still not enough for her needs in the future. So to augment these plants, which are making sea water drinkable, it was decided to investigate the idea of hauling towering icebergs across the Southern Hemisphere.

Financial experts worked out that it would cost a mere \$50 million to get the scheme going—a grain of sand in the Saudi Arabian treasury, but still a big saving compared with the existing method.

But was it feasible? Wouldn't the icebergs melt in the sun on the journey north? After all, the distance from the Antarctic to the Middle East is vast.

Prince Mohammed al Faisal, chairman of the Saudi Saline Water Conversion Corporation, approached M. Paul-Emil Victor, a polar explorer of considerable experience, who was able to call upon the resources of the powerful French Cicero Trading Company.

M. Victor felt there was nothing to stop such a scheme

from total success. He had, in fact, been working on the principles of the idea for many years. He envisaged tugs pulling icebergs across the Indian Ocean and into the Red Sea to provide water for Saudi Arabian industrial development.

But first, a host of problems had to be solved, involving oceanographical aspects, meteorological questions, difficulties posed by glaciological tendencies and baffling marine and biological puzzles. This was in addition to basic hurdles like cost and legal details. Enormous planning, as daunting as the icebergs themselves, faced M. Victor and his team.

Initially, photographs will have to be taken by satellites crisscrossing the skies above the Antarctic to determine the best places to obtain the icebergs. They will also track the movement of icebergs as they break away from the polar slab.

Ocean currents will also have to be studied by the satellites so that the best routes north can be chosen.

Planes will then fly over the selected sites to make assessments of the shape, thickness and nature of the icebergs.

Workers toiling under the hot Arabian sun need water to irrigate their fields and to slake their thirsts (left). Will icebergs be their salvation?



MOVING THE ANTARCTIC TO ARABIA

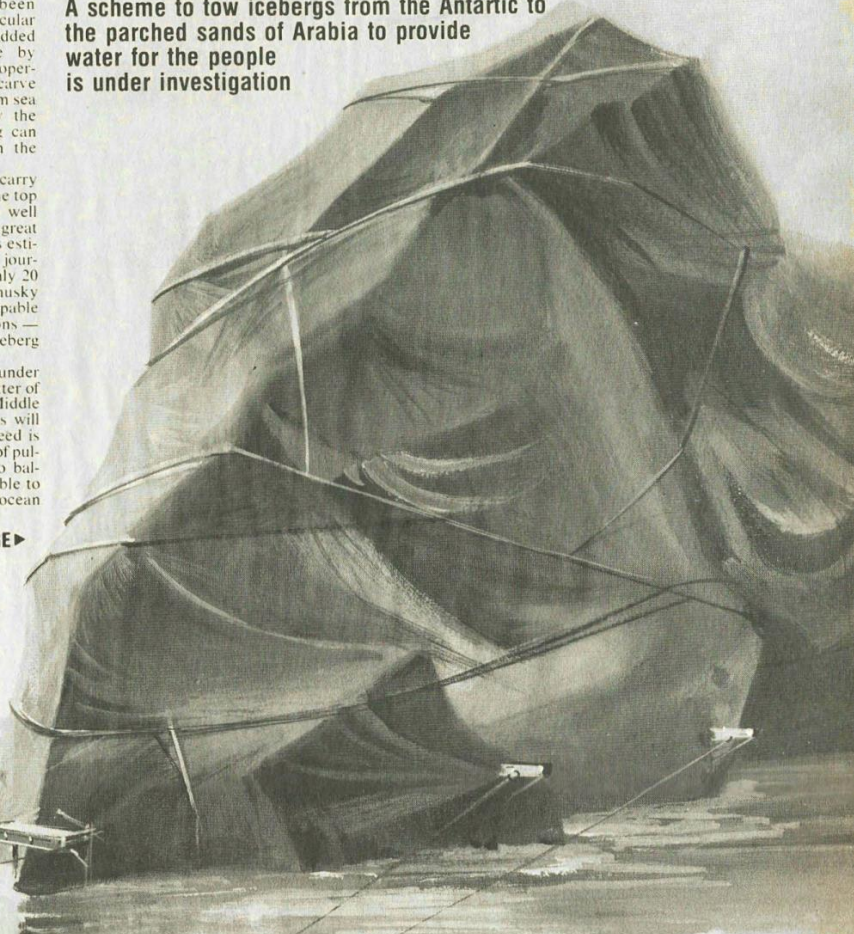
When an iceberg has been selected, it will have five circular steel anchor points embedded deep beneath its surface by heated tubes. Steel hawsers operated by heated weights will carve a bow on the icy surface from sea level down to well below the waves, so that the iceberg can plough through the sea in the same way as a ship.

The hawsers will also carry plastic sheeting pegged to the top of the iceberg to positions well below the sea to prevent any great loss by melting. In fact, it is estimated that throughout the journey the iceberg will lose only 20 per cent of its weight. Five husky ocean-going tugs—each capable of a towing power of 120 tons—will be needed to tow the iceberg north.

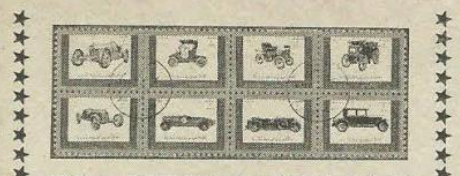
Even this operation once under way will not be a simple matter of a slow journey to the Middle East. All the way, the tugs will have to ensure that the speed is constant and that the force of pulling the iceberg along is so balanced that the ice will be able to withstand the stresses of ocean travel without cracking up.

CONTINUED ON NEXT PAGE ▶

A scheme to tow icebergs from the Antarctic to the parched sands of Arabia to provide water for the people is under investigation



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Indeed, so meticulous will be the voyage that the experts estimate that it will take about six months at a speed of one knot an hour to complete the journey from the Antarctic Sea to the South Arabian coast.

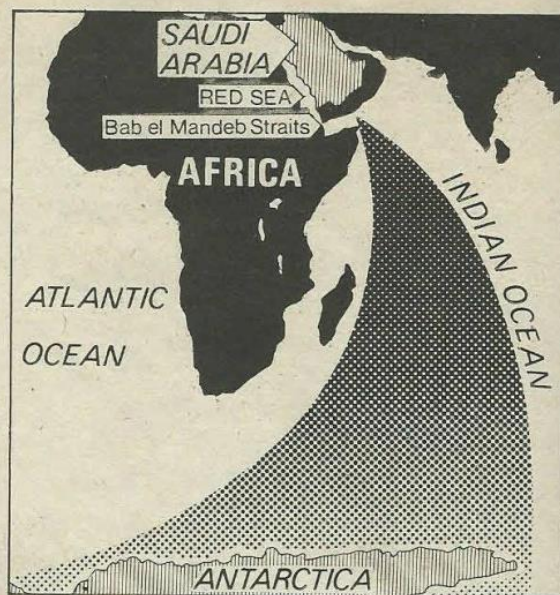
And although such an immense structure of ice will be able to withstand the rigours of southern tempests, it will face an even more difficult problem when it reaches its destination. For the iceberg will be too big to enter the narrow Bab el Mandeb Straits leading from the Indian Ocean into the Red Sea and the Saudi Arabian western coast.

Such a problem did not deter the indefatigable M. Victor. He decided that at this point each iceberg would have to be sliced up into smaller ones!

Thermal drilling, already used with success in polar regions, will be used to cut through the ice with the ease of cutting a block of butter with thin wire. The idea is to cut the icebergs up into separate one million ton slices and then tow them, one by one, to their ultimate destinations.

Experts maintain that the cost of water delivered to Jeddah by the smallest icebergs will be about two thirds of the cost of making fresh water from sea water.

If the operation is as successful as its originators hope, it will have



far-reaching effects, not just for Saudi Arabia. It will have proved that it should be possible to beat the droughts that have ravaged Africa, Asia and even Europe.

Certainly, Arabia will experience an unusual phenomenon. By lowering the temperature of nearby land by three or four degrees, the iceberg will create the first sea mist ever seen by the Arabs.

Mountains of ice may travel from Antarctica to Saudi Arabia on the route shown on this map.



Crops flourishing in the sands of Saudi Arabia? It seems an impossibility; but, with the help of water from the Antarctic, the 'impossible' could happen

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1. That an object is for sale by auction.
2. In the docks.
3. A coin, first issued in Britain in 1351.
4. Gypsy Moth.
5. The elephant.
6. Hockey.
7. A flowering shrub.
8. Union of Soviet Socialist Republics.
9. On the left hand side.
10. At the southern tip of Africa.
11. Once bitten twice shy.
12. William Tell. It was in Altdorf that he is said to have shot the apple from off his son's head.
13. Anna Sewell.
14. St. Francis of Assisi.
15. A beer.
16. A general who became president of the USA in 1868.
17. A pharmacist or druggist.
18. The Democratic Party.
19. Brasilia.
20. Liverpool.

PICTURE PUZZLE

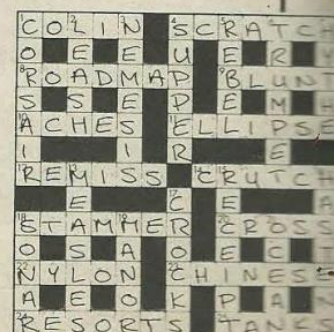
a. Roman and pre-Roman. b. Tudor. c. Georgian.

WHAT ON EARTH...

The object is a fibre-tip pen.

CHESS PROBLEM

1. --- R(K5)×P ch.
2. B×R R×B ch.
3. P×R Q—R6 mate.



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GREAT BALLS OF FIRE

READ ABOUT THEM INSIDE





Speed & Power

Although their interiors should be comfortably cool, thanks to the use of a heat-resistant covering, the space shuttles of the future will glow with a fiery intensity

GREAT BALLS OF FIRE

"PREPARE for earth-atmosphere re-entry," crisply ordered the commander of the space shuttle.

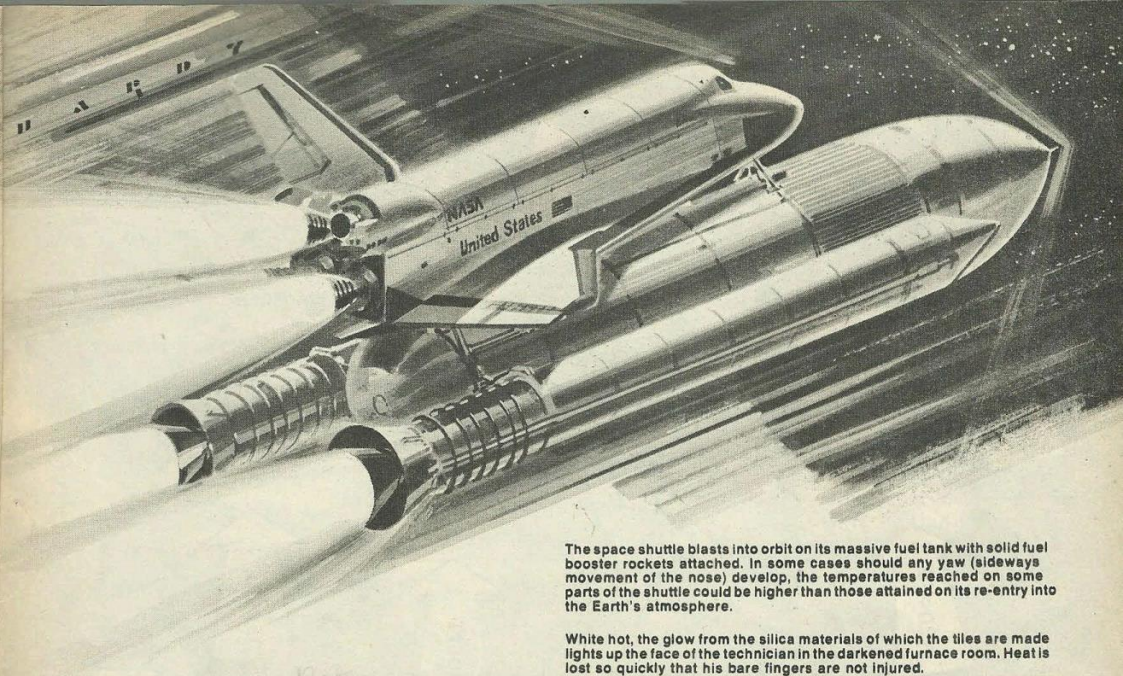
The scientists returning to Earth after a spell of duty in an orbiting space laboratory looked at each other anxiously.

Grimly, they fastened their seat belts and steeled themselves for the tremendous pull of the Earth's gravity.

Even more frightening was the fact that as their shuttle hurtled at an incredibly fast speed into the mixture of gases that surround the Earth, the exterior skin of their shuttle would become a ball of fire, more intensely hot than the hottest furnace.

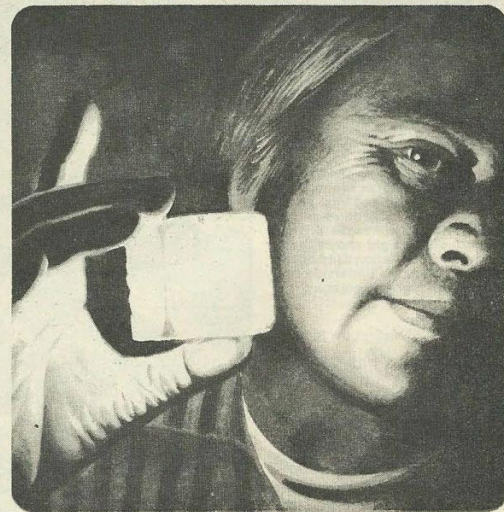
Officials at the North America Space Administration headquarters were tracking the shuttle on their radar screens. A mass of technical information from the shuttle was fed to a myriad of dials. The one that attracted a lot of attention

Close-up of the orbiter nose shows the pattern of tiles that act as a heat shield and protect the craft from the effect of the high temperatures that are created as it speeds through the Earth's atmosphere. The craft's contours complicate the task of fitting the tiles together.



The space shuttle blasts into orbit on its massive fuel tank with solid fuel booster rockets attached. In some cases should any yaw (sideways movement of the nose) develop, the temperatures reached on some parts of the shuttle could be higher than those attained on its re-entry into the Earth's atmosphere.

White hot, the glow from the silica materials of which the tiles are made lights up the face of the technician in the darkened furnace room. Heat is lost so quickly that his bare fingers are not injured.



was a temperature indicator. It showed how hot it was on the skin of the craft and how hot it was inside where, if the thermal protection failed, the scientists could be roasted alive.

But the NASA officials were not all that worried. They were pinning their faith on a coating of heat-resistant tiles that covered the outer casing of the shuttle. As the shuttle raced through the air, the friction between it and the atmosphere created the incredibly intense heat that the scientists anticipated.

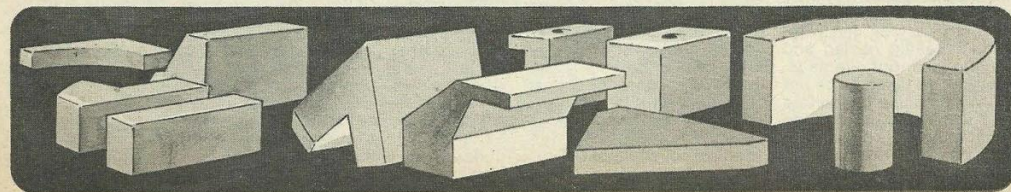
However, inside the shuttle the passengers felt warm,

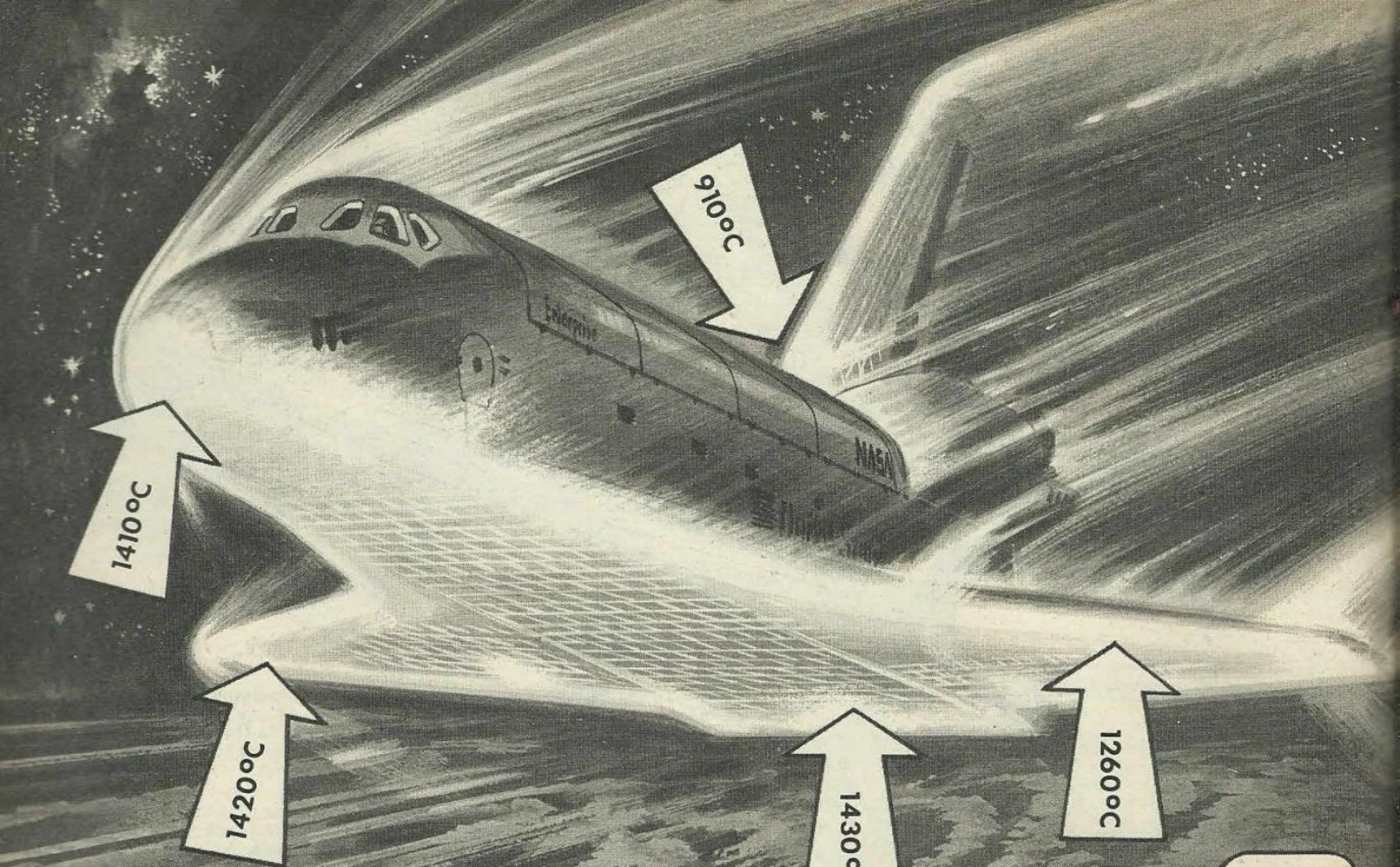
but not uncomfortably so. And when their shuttle landed like a conventional jet plane, they stepped out, glad to be home and physically unharmed by the experience they had been through.

Amazing? Incredible? Of course! But scenes like this could become regular occurrences in years to come, when shuttles are shot off to space laboratories on the back of a rocket and brought back to earth like a returning capsule — but with wings with which they can land on a runway.

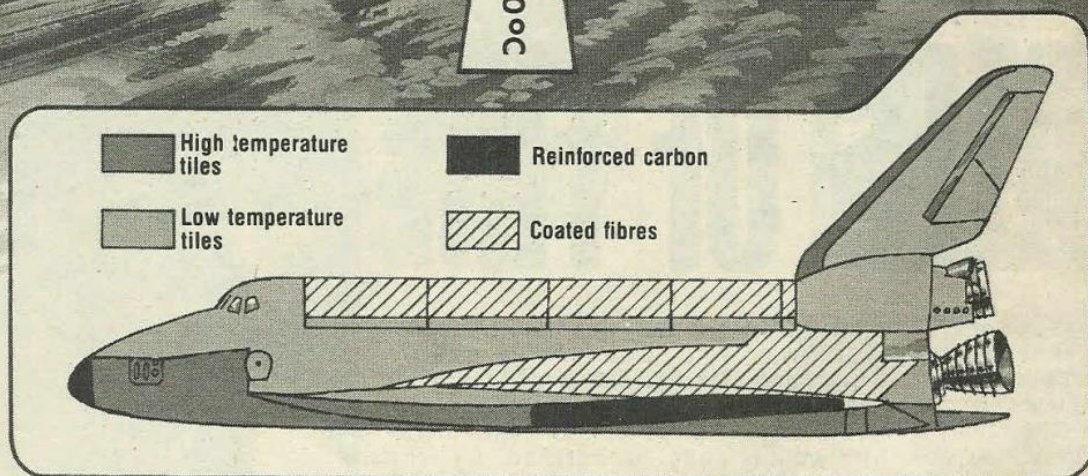
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Some of the many thousands of different shapes into which the tiles are cut are shown below.





The illustration above shows the searing temperatures reached on the most exposed and vital areas of the shuttle-orbiter on re-entry into the Earth's atmosphere. The diagram on the right shows the four types of insulation used on the vehicle. The entire underside is coated with high-temperature tiles.



The problem has been to provide the shuttle with a protective skin that can stand up to a hundred re-entries without failing.

After many experiments, America's Lockheed company made some tiles which could be fastened to the exterior of the shuttle. They are designed to lose their surface heat very rapidly so that they do not convey it, by conduction, to the shuttle's shell. These tiles can withstand repeated heated and cooling without damage. They can be taken white hot from a kiln and plunged into cold water without coming to harm. And it is possible to hold one with the bare fingers without injury while it is

still glowing white hot after being heated in an oven.

The basic raw material for the tiles is sand, from which are made the silica fibres that compose the tiles.

A cement containing the fibres is mixed with water and a binder, and cast into soft, porous blocks. Tiles are cut from these blocks, coated with a silica mixture and then baked.

Tiles for the underside of the shuttle receive a glass coating that can resist very high temperatures. Those intended for the upper surfaces have a white shiny surface intended to reflect the sun's rays and keep the shuttle cool while in orbit.

A waterproofing com-

pound is added to prevent the tiles from absorbing extra weight in rain or humidity.

Cutting the tiles to fit the complex shape of a space shuttle is so complicated that no two tiles are exactly alike. Computer-controlled milling machines are used to cut them. Fitting them on to the space craft could be as tricky as assembling a jigsaw puzzle twice the size of a tennis court.

To further complicate matters, the small gaps between the tiles — from where air trapped by the tiles is allowed to escape to prevent expansion — must be uniform to within a very small margin.

Nearly 34,000 tiles will be used to cover about 70 per cent of the aircraft's surface.

When the first shuttle travels in space it will be after a succession of tests carried out with the shuttle on the back of a carrier craft. At first it will be unmanned. Manned pick-a-back flights will follow and then, in July this year, the shuttle is expected to separate from its carrier for the first time and glide back to earth.

If these are considered successful enough for the shuttle to be put into orbit, the covering of tiles will be applied and the shuttle will take-off into space and herald a new phase in the exploration of the unknown.

**Speed
& Power**

ICE-BREAKER

When ice blocks the rivers of Canada, an unusual vehicle is brought into use to free the waterways of their frozen obstructions

If you think Britain's winters are cold — and sometimes they certainly feel so with the temperatures below freezing — spare a thought for the people of North America. There, particularly in Canada, winter invariably brings both heavy snow and low temperatures. Sometimes the thermometer drops to minus 20°C, and often registers 12 or 15 below zero.

The temperature may remain as low as

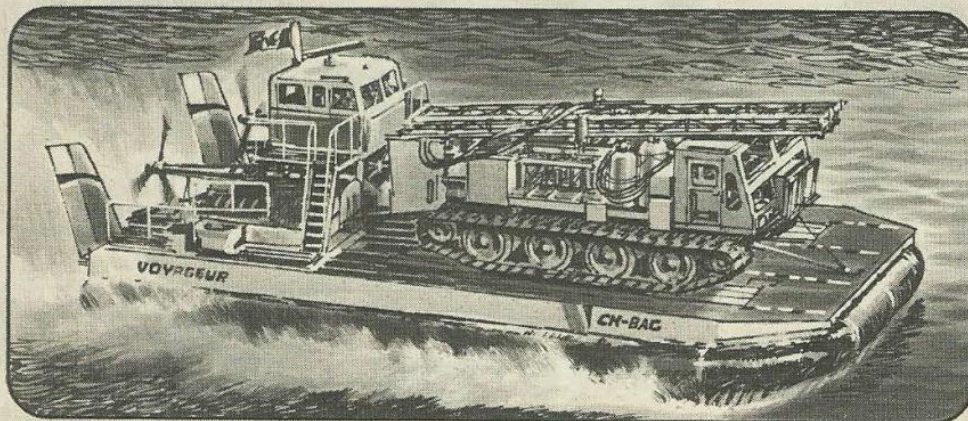
this for many weeks at a time, and this means that rivers and other open stretches of water become jammed with very thick ice. As rivers are used for transporting fuel and manufactured goods, having them jammed with ice can bring many problems and even hardship to people who rely on oil for heating their homes.

Ice often builds up into great blocks which act like an artificial dam, and when

the thaw comes in the spring, water which has built up behind the ice dam can suddenly burst through, causing severe flooding.

In an effort to clear some rivers, and particularly the Riviere des Prairies north of Montreal in Quebec Province, the Canadian Coast Guard have been making use of a most unusual ice-breaker — a hovercraft, or air cushion vehicle. The hovercraft, a Voyageur ACV, is a 45-ton craft and can operate where the river is too shallow for the use of ordinary ice-breakers.

The ice jam-up in the Riviere des Prairies forms in mid-winter underneath a layer of solid ice about 30 cm thick (1 ft). The river current brings chunks of snow and ice from upstream which become caught under the surface ice. This gradually builds up until, at some point, it reaches the river bed.



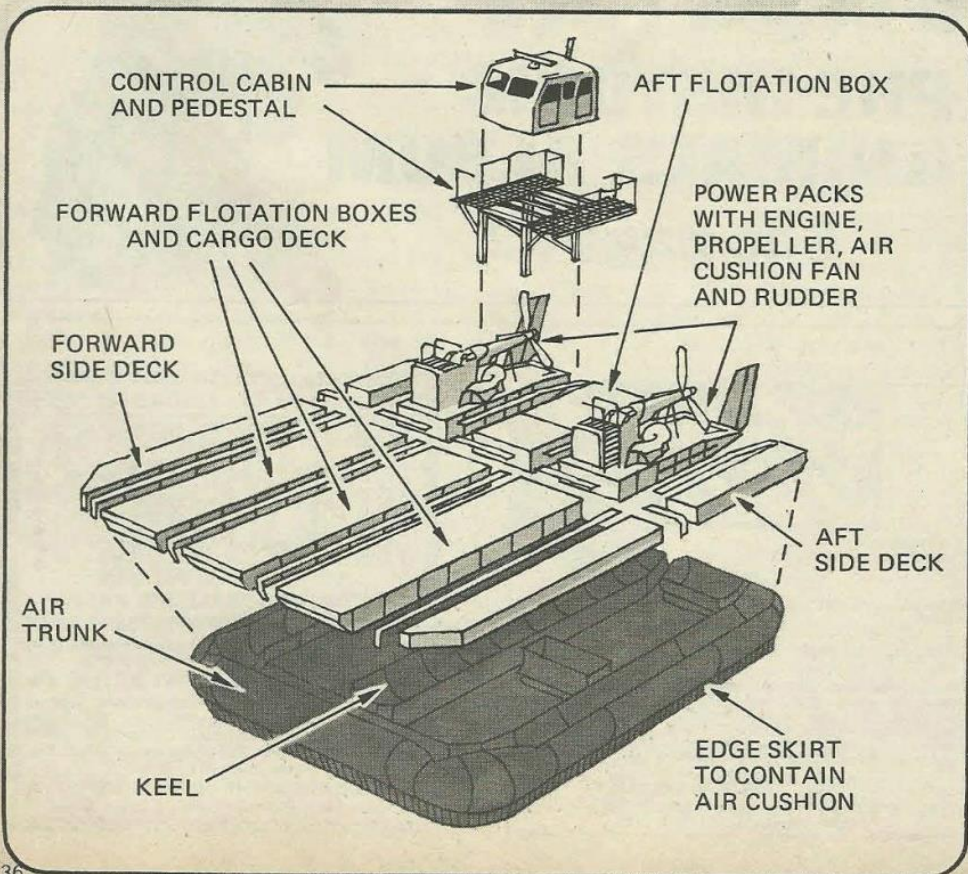
CLEARING THE JAM

The crew of the hovercraft tackled its ice-breaking job piecemeal by using the weight of the vessel to compress and crack the jammed ice. Waves set up by the movements of the craft lift ice that has been grounded on the river bed, and allow it to drift downstream with the current.

The ice-jam broken up by the Voyageur's crew varied in thickness. Some of the largest chunks that turned sideways were measured and found to be nearly five metres thick (17 ft).

A different kind of ice-jam was cleared by the hovercraft on Riviere Chateauguay, which flows into Lake St. Louis south of Montreal. This pack ice was solid and ranged from 32 cm (about 13 inches) thick at the mouth of the river, to clear water two-kilometres up-stream.

In order to break this thickness, Voyageur was operated at a speed of 15 knots back and forth across the ice. This caused standing waves of ice similar to the type of waves formed in water. The wave action made the ice crack and shatter with some violence, allowing it to be carried away by the current.



As a cargo carrier, the Textron/Bell Voyageur can transport up to 25 tons of payload at 50 mph (80 km/hr) over water, land, mud, marsh, ice, snow or frozen tundra. It is shown (top left) carrying an Alaska North Slope oil exploration drilling rig. The diagram (left) shows its simple unit construction. It is designed as 12 major units and an air cushion skirt. When separated, these units are easily carried long distances by road, rail or air for rapid assembly at the work site.



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MAN-MADE MONSTERS

SEE INSIDE



MAGICIANS OF THE MOVIES

Man-Made Monsters

Terrifying creatures of tremendous size and ferocity are the stock-in-trade of the horror film industry. But the frightening beasts you see on the screen are not always what they seem.

WITH incredible gentleness for so vast a creature, the monster plucked the girl from the sacrificial altar on which she had been placed by a band of frightened tribesmen, and held her in its great hands.

Shouting, screaming and pummeling were of no avail.

In any case, the monster intended her no harm. Its eyes glared at her intently and its nostrils quivered.

What manner of maiden was this? Or, more to the point, what manner of monster was this?

Filmgoers who have seen the new version of "King Kong" have found out the

answer to this. King Kong is a film in which the makers have created an enormous ape which terrifies all who see it.

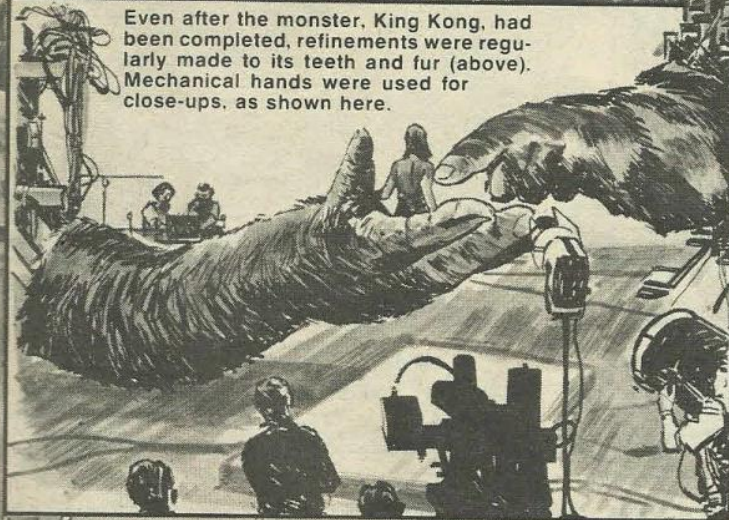
In addition to the monster, trick photography was needed to lend realism to the scenes in which the monster appears with humans.

Making King Kong was a mammoth undertaking. For his skeleton, metal — mostly aluminium — was used. So that he would be able to walk, turn at the waist and move his arms into 16 different positions, tremendous lengths of hydraulic hose and electrical wires ran

CONTINUED ON NEXT PAGE ►



Even after the monster, King Kong, had been completed, refinements were regularly made to its teeth and fur (above). Mechanical hands were used for close-ups, as shown here.



through his body like arteries and veins.

For his fur, the makers obtained thousands of horse tails from Argentina. The hair from these was woven by a hundred people into netting panels which were glued on to latex and then stuck to a plastic mould that covered the monster's metal frame.

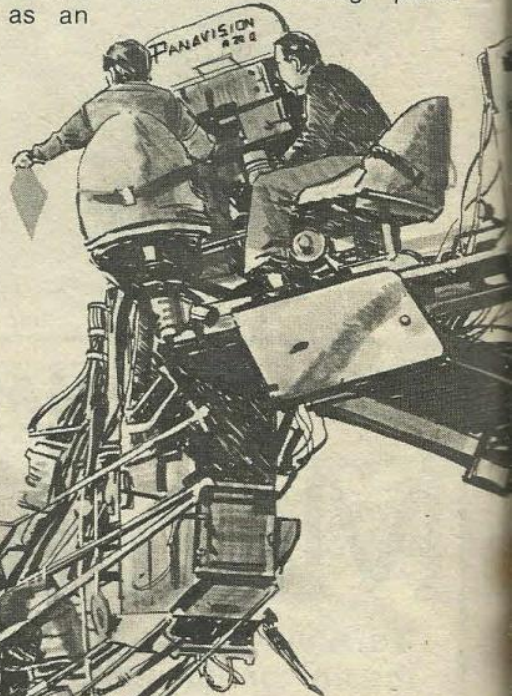
The finished product was a mighty, terrifying monster nearly as tall as seven men. Colossal scenery had to be built to accommodate the outsize "actor". One example of this was a huge wall from which Kong snatched a girl who was placed there as a sacrifice to him.

But for other scenes, King Kong, or the parts of him that were required, such as his hands, were photographed against a blue screen in the studio. Following a complex series of laboratory printing operations, a film was produced in which the blue backing was shown as clear film with the foreground action as an opaque silhouette.

An optical printer of the type described last week was then used to combine the foreground movement with a background scene, such as a jungle in the case of "King Kong". The result was a convincing and realistic marriage between the background and foreground so that they appeared as one.

With the aid of methods like these, King Kong's dismembered hands can be filmed in the foreground with his head in the background, so that he really appears to be holding something in his hands and looking at it.

Equally as terrifying as King Kong and just as horrific was the shark in "Jaws" whose part was played by a real shark in some scenes and by three different mechanical sharks in others. One could only be filmed from the right because its machinery was exposed on the left. Another had its working parts



This is what it was like in the studio when shots were made of King Kong snatching his victim from a high sacrificial altar. A hand, manipulated from a boom, grasps the girl in a realistic imitation of the great ape's movements.



exposed on the left and could only be filmed from the opposite side, while a third model was a complete shark that was towed behind a boat and used for over-head shots.

This was the simplest of the three. The others were packed with hydraulic, pneumatic and electronic equipment.

Each was attached by a boom to a sunken platform. Worked by remote control, the boom — or arm — gave the shark movement, raising it to the sea's surface, as well as causing it to sail out of the water and to dive back into it when required.

Tubular steel was used for the backbones of these mechanical monsters. Inside each shark was a vast quantity of plastic tubing, plus 25 valves operated by remote control and 20 electric cables and pneumatic hoses which powered the varied moving parts including the ferocious jaws.

Indeed, these jaws were so awesome that each shark was fitted with two sets of teeth. One set was made of plastic so that they looked

like the real thing. Another set was moulded in rubber to enable the stunt men who were attacked by the whale to remain alive for the next take.

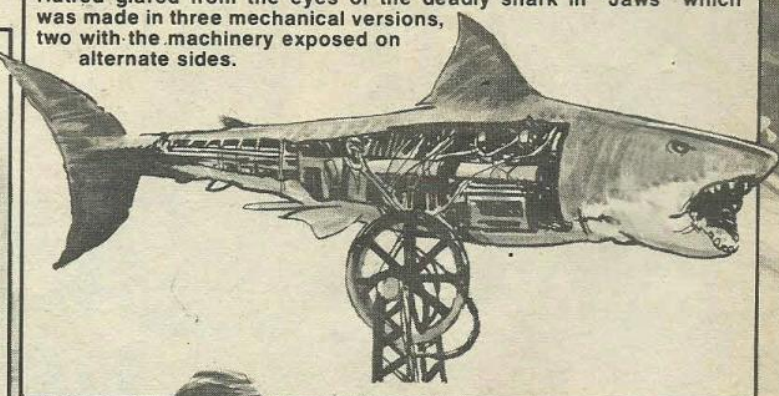
Because they were almost always under water, the mechanical whales needed a lot of maintenance. The sea water rusted the metal parts and repairs were frequently needed. And a new plastic outer skin was required each week because of the bleaching power of the sun and salt water.

Monsters of many frightening kinds have been created for films. Among these was a horrific sea monster which was seen in "The Creature from the Black Lagoon". This monster was part-fish and part-reptile and the size of a man. Its costume was worn by a skilled swimmer who was able to stay under water for five minutes without breathing.

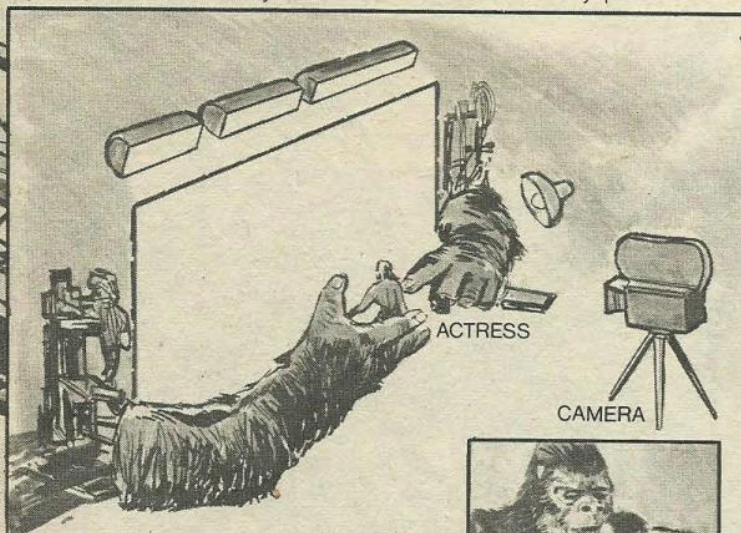
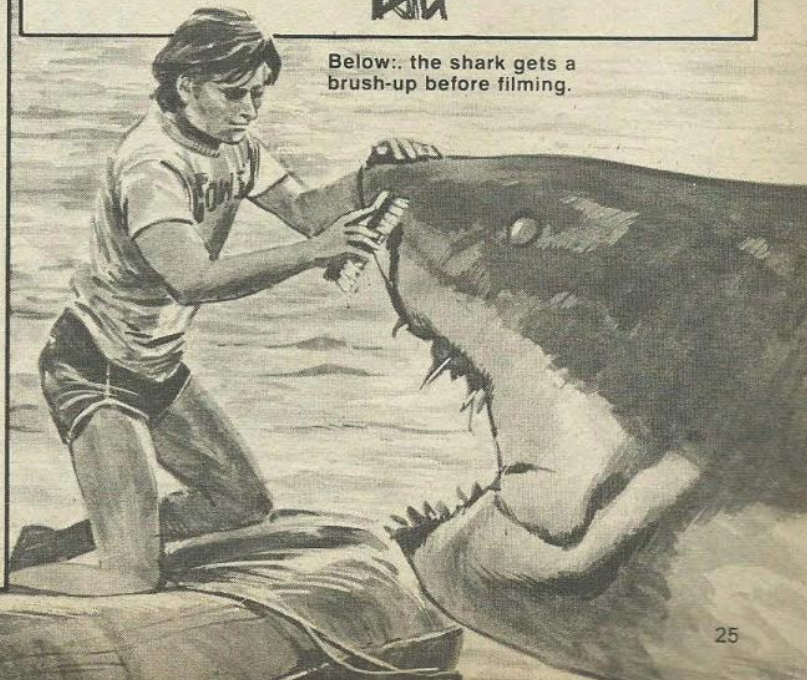
Tricks like these enable the film makers to bring our fantasies alive and create for us an amazing world in which the impossible becomes vividly possible!



Hatred glared from the eyes of the deadly shark in "Jaws" which was made in three mechanical versions, two with the machinery exposed on alternate sides.



Below: the shark gets a brush-up before filming.

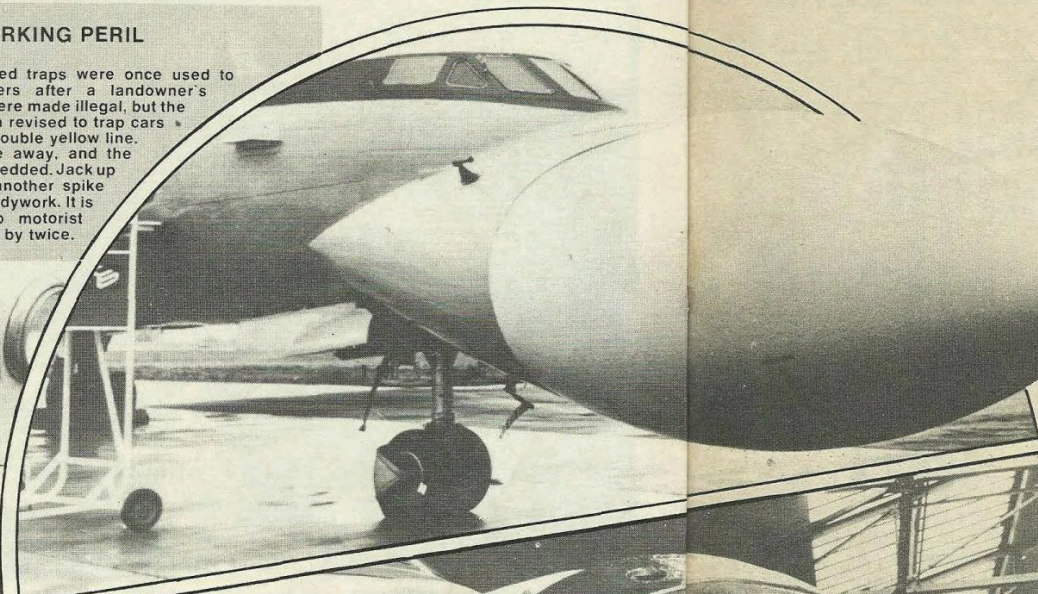
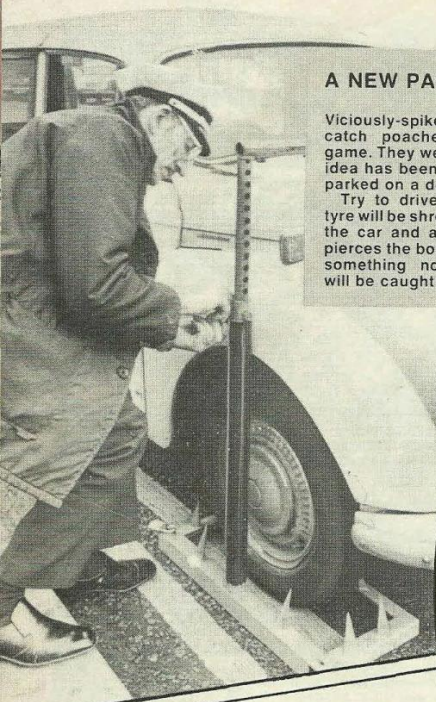


When he had to be shown holding a living person, King Kong's hands had to be filmed separately from his head, so that the arms could be manipulated mechanically. Afterwards, the two films were put together and a realistic effect obtained. To achieve this, the hands were filmed against a blue background. This, after a complex laboratory process, produced a film of the hands with a transparent background. The backing film was then treated to make the area occupied by the hands transparent, and the two films were then projected together on to a negative to make the finished picture. Trick photography of this kind is often used to create backgrounds which are not otherwise available. Location crews can film castles, mountains or ships at sea and marry these with shots of actors taken in a studio. Models of futuristic space craft can be made to appear enormous when shots of them are combined with scenes of actors.

A NEW PARKING PERIL

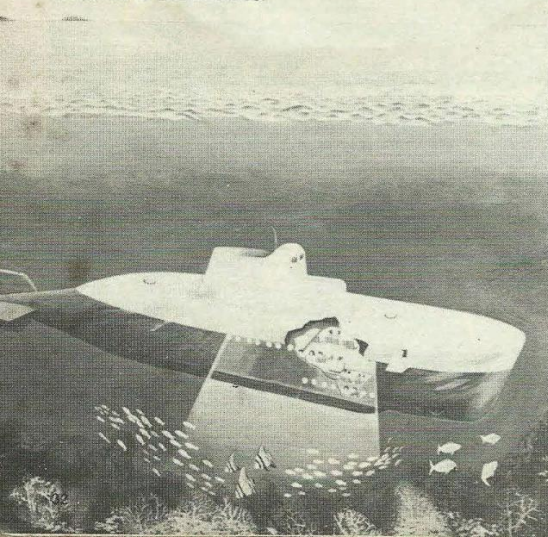
Viciously-spiked traps were once used to catch poachers after a landowner's game. They were made illegal, but the idea has been revised to trap cars parked on a double yellow line.

Try to drive away, and the tyre will be shredded. Jack up the car and another spike pierces the bodywork. It is something no motorist will be caught by twice.



THE UNDERSEA SIGHTSEERS

Up to 48 passengers at a time will be able to see the undersea wonders around the coasts of Japan. They will ride beneath the waves in the world's first self-propelled submarine for sightseers. From the observation lounge's circular port hole, they will see sights previously seen only by skin divers and scientists in submersibles.



BRITAIN'S FRONT-LINE DEFENDERS

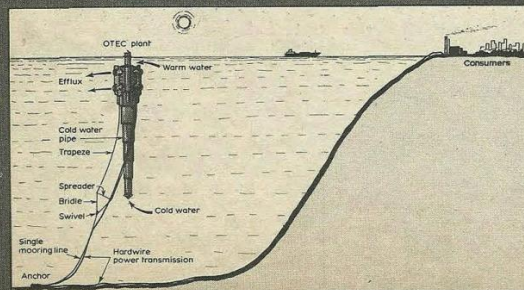
A new eye in the sky is being developed in Britain. It is the Nimrod AEW (airborne early warning) aircraft that will have a big radar pod in its nose, as shown in our pictures above.

With this equipment, it will nose out aircraft flying too low for ground radar to detect, because they would be hidden by the horizon beyond which radar cannot reach.

Designed as part of an early warning system, to alert the

West of a possible attack, the Nimrod will be able to track ships as well as aircraft. Up to a thousand targets will be received and identified simultaneously, including objects crossing at high speeds. The radar will be able to recognise helicopters by their special characteristics, reject echoes from the ground and yet pick out slow moving ships.

They should be formidable airborne sentinels.



SCIENCE SURVEY

A look at scientific progress in the air, on the land and under the water

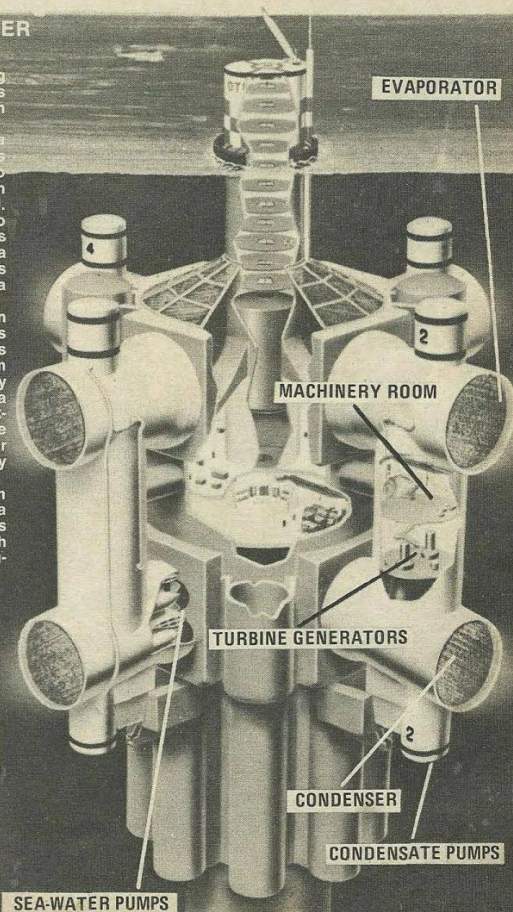
OCEANS OF POWER FOR THE TAKING

Experiments in obtaining energy from the oceans are being conducted in America.

The idea is to take a medium, such as ammonia, conduct it to deep water through pipes, where it is cooled. As the ammonia rises to the surface, it vaporises and turns the fans of a generator, which makes electricity that is fed to a shore station by cable.

The ammonia is then cooled and the cycle is repeated. This idea is shown in the diagram below. And the cutaway on the right illustrates a design proposed by Lockheed of America. (The initials OTEC stand for Ocean Thermal Energy Conversion).

A string of such generators set in the sea around a nation's coasts could provide it with much of the power regularly needed.



ELDORADO OF THE DEEP

Fathoms Deep Farms of the Future

In this first of a new series about the world beneath the surface of the oceans we look forward to the realisation of a dream of farmlands under the sea — a dream that will soon come true

LIKE a cluster of subterranean flying saucers, the cone-topped dwellings hover just above the sea-bed, tugging gently on the wire stays that anchor them down.

From beneath these strange buildings, skin-divers emerge and set off on their daily inspection of cages where fish and marine life are specially bred for the underwater farm. Others examine the ocean floor for traces of valuable ores or unusual types of seaweed, which might be used for food — either for themselves or for the fish they look after under the sea.

For man is today on the threshold of entering the new world beckoning from Davy Jones' locker deep beneath the waves. And although he is already feverishly busy exploiting the sea for the oil and gas that lurk beneath the stony bottom and for the mineral riches that lie hidden among the sweep and curve of submarine mountain ranges, man's knowledge of this vast kingdom is still minuscule. Undoubtedly, his apprehension is understandable as he prepares to probe the marine world where until now he has been little more than a nomad.

Yet devising real subterranean villages where men and women can live

for up to a month at a time has advanced beyond the planning stage. A new fishing technique is even beginning to emerge from the researches of the marine scientist — aquaculture. This involves actually supervising the breeding of fish in their natural environment — not just catching them as food.

SCIENTIST'S DREAM

Indeed, the dream of a French marine scientist, M. Jacques Rougerie, is gradually becoming a reality. He is the founder of an organisation dedicated to building villages beneath the sea and so enable people to become integrated in the marine milieu. It is called Centre d'architecture de la mer — or CAM for short.

CAM has a plan for settling a "sea nation" on a site off the Virgin Islands in the Caribbean. Each dwelling will accommodate between 10 and 20 marine enthusiasts, who will live in a shell within a reinforced concrete frame. There will be one big communal room, with bedrooms, laboratories, bathrooms and lavatories. Around the entire "house" will be wrapped a tough

plastic sheet with wire stays acting as anchors so that it can be set up above any uneven sea bottom.

Ideally, they will be established on the continental shelf where there is a minimum of current or swell.

The aquanauts' mission will be to control and explore the area around their "village" under direction from a surface ship equipped with the latest oceanographic aids. Buoys set up around the "village" will create lanes leading to cages where fish can be kept and nourished just as animals are cared for on any farm on land.

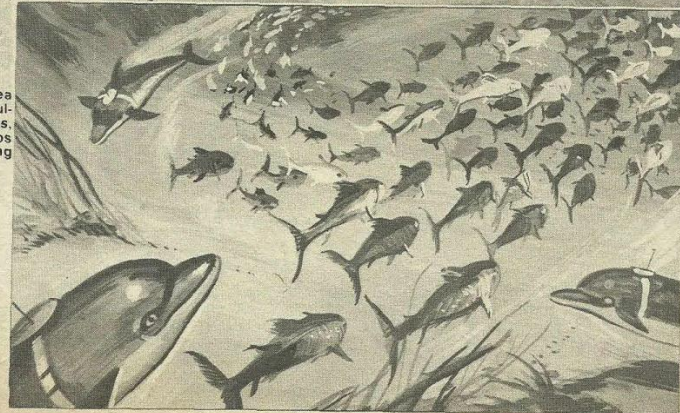
The entire concept of aquaculture also envisages the creation of a marine peasantry able not only to manage, understand and protect the sea, but also to select the most interesting productive fish so as to increase their numbers and improve their quality. Indeed M. Rougerie believes that aquatic animals would be treated like domestic animals with all phases of their lives controlled from the moment of birth. He even believes that special selection of the best varieties of each species could be made.

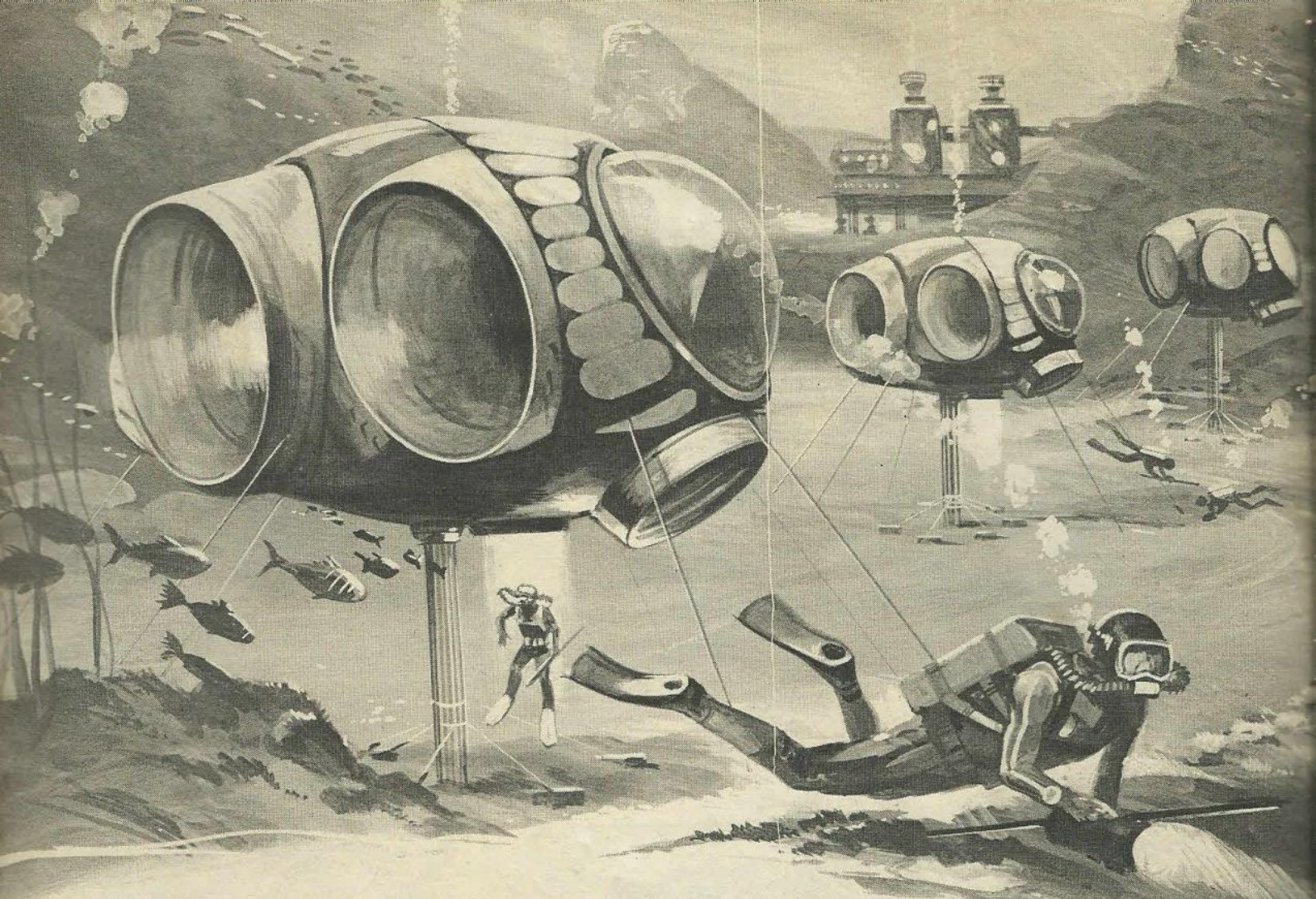
His idea is to keep them in captivity until they have grown big enough for

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A vivid glimpse of submarine villages and sea farms designed for researchers and aquaculturists. And on the right are trained porpoises, radio-equipped to receive commands. Perhaps they could become ocean cowboys, herding schools of fish.





Our artist's impression of the submarine house "Galathée".

the fish markets or, at least, until they are big enough to be returned to the sea to improve traditional fishing by trawlers.

This kind of breeding will be carried out in hatcheries for the larval stages of reproduction and in floating cages to fatten them up. This, in essence, is the beginning of the first stage in creating a real marine aquaculture.

Later, the underwater farm will be stocked with shoals of fish, which will be looked after until ready for transporting by tractor to designated zones for sorting and despatch to factory ships waiting above.

As aquaculture develops, so will the aquanauts become accustomed to their new surroundings and discover that they can be just as at home in the sea as on land. They will find, the scientists say, that they can actually achieve an understanding with fish just as the farmer has with his sheep or cattle. This has, of course, already proved true with dolphins, which respond intelligently to human commands. But these are mammals, not fish.

Before accepting his new strange environment, the aquanaut of the future will face many physiological problems. He will have to become accustomed to a new idea of space that goes on and on seemingly into a watery infinity, sometimes plunging down into an abyss. Moving about on the seabed will inevitably present some of the sensations of weightlessness which spacemen have had to overcome in orbiting the earth. The effects of pressure on the body, the limited vision beneath the sea and fears that arise in a

noiseless world will all have to be studied as the aquanaut becomes acclimatised to his surroundings.

As a beginning CAM has set up a submarine house called Galathée, which is not just for the specialist but for all underwater enthusiasts who want to explore the submarine world.

It will be inaugurated shortly beneath the Mediterranean near Port-Cros and the island of Levant. As a prototype that could serve as a base for submarine sports or for research, it will offer the chance of working on the spot for up to three weeks or a month. And so the prospect of holidays beneath the sea has appeared and may one day be just as acceptable as spending a vacation at the seaside or in the mountains.

France has been experimenting with the idea of enabling man to live under the sea for several years. But so have other countries like the United States, Canada, West Germany, the U.S.S.R. and Japan. For the sea hides many undreamt-of riches and possibilities and the international race to collect them has only just begun.

**One day — and it may not be
so very far in the future —
farms, homes and even
holiday resorts may flourish
on the ocean floor**

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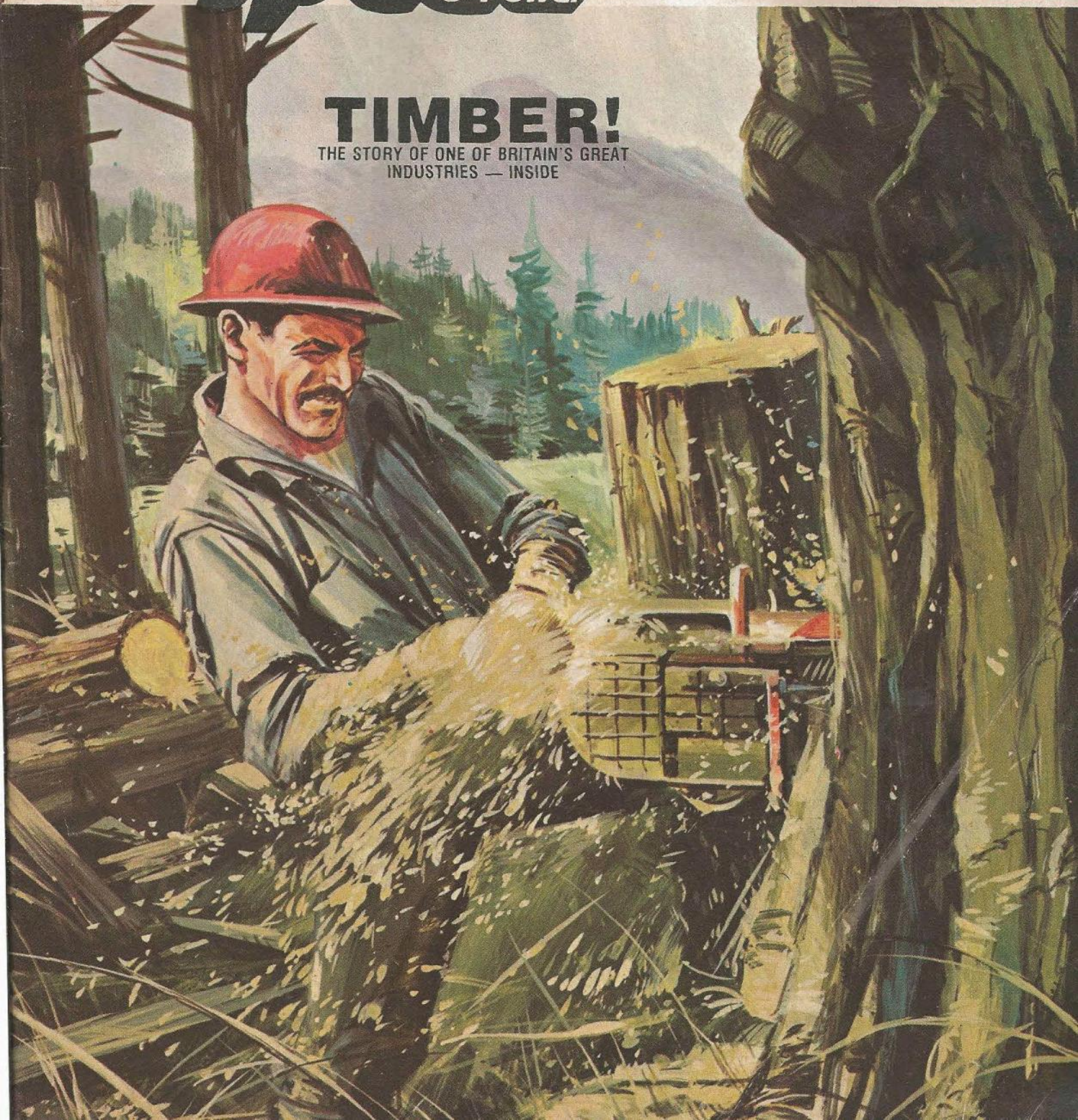
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ELDORADO OF THE DEEP

Fortune On The Ocean Floor

On the bed of the South Pacific lie nodules so chock-full of precious metals, metals so vital to us that their value is unimaginable

ONE day last February, a freighter left the Oregon harbour of Portland and nosed quietly into the deep ravine of the Columbia River on the first lap of the greatest treasure hunt of all time.

The German officers, Spanish crewmen and American mining experts aboard the 545-ton *Deep Sea Miner II* were not dreaming of golden doubloons and jewels cascading from some ancient chest lodged in the sunken wreck of a long-forgotten galleon. They were on the trail of the natural trove of the deep — King Neptune's very own treasure that is worth untold millions to the men who can pluck it off the sea-bed beneath the oceans of the world.

There, miles beneath the waves in the wandering abysses of the sea-bed lie strange, briquette-like lumps known as nodules, impregnated with precious ores sought by every nation in the world. Set in these nodules, which range in size

from potatoes to footballs, is manganese — the mineral that toughens steel — and copper, nickel, cobalt and 30 other metals.

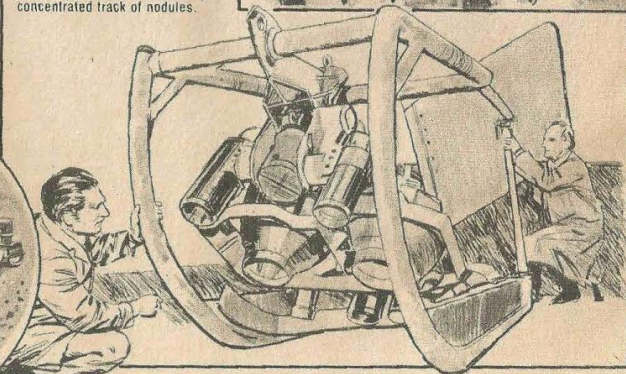
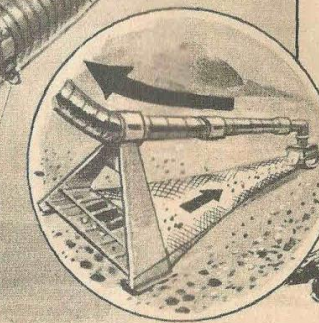
The South Pacific alone is estimated to contain as much as 1.5 million tons of nodules, and so at roughly £150 a ton, the potential economic boom from developing this single region enters the realm of the unimaginable.

United States defence experts have even come up with some equally staggering figures that confirm the existence of a veritable Eldorado of the Deep. They reckon that the Pacific can provide enough copper for 1,100 years, enough nickel for 23,500 years, enough manganese for 34,800 years and enough cobalt for 260,000 years.

And, strangely enough, every year more and more nodules are being thrown up by mysterious convulsions and volcanic eruptions in the inky depths. Some

Our main picture shows a sled type nodule collector with cameras mounted on the front bar. Note the cutaway showing nodules being sucked up. The pipe to the surface is not drawn to proportion. The depth could be 6,000 metres.

Right: The nodule deposit shown on a TV monitor. Below: A German TV camera sled capable of working at 6,000 metres deep. Below left: A dragnet type nodule collector with a suction pipe system to pick up a concentrated track of nodules.



55,000 tons of copper are added annually to the Pacific Ocean floor.

Yet how can these nodules be gathered from such vast depths? Officials of Deepsea Ventures Incorporated, the combine behind the voyage of the *Deep Sea Miner II*, believe they have the answer.

OCEAN MINERS

These pioneer miners of the ocean floor, which lies up to three miles beneath the heaving decks of their converted ore carrier, have for many years been perfecting methods of bringing the prized nodules to the surface.

They tried slinging a cable attached to it down to the sea-bed where the nodules were dredged up. They hoped to produce 3,000 tons over two years but, in fact, this laborious, hit-and-miss process only yielded seven tons.

Today, they favour a hydraulic system, which is like a gigantic vacuum cleaner. A pipeline connects the ship with a dredge-head that moves systematically over the sea-bed. Compressed air is forced into the pipeline at several points. As it rises inside the pipeline, the bubbles expand creating a lifting force that sucks the nodules up to the surface and the waiting ship.

So far the financial backers, the US Steel Corporation and Union Minière of Belgium, have pumped about £12 million into the scheme, which they estimate could cost more than £300 million if a full-scale plant for processing the minerals is built. Until that stage is reached, however, the minerals found in the nodules will be processed in Belgium.

FIRST CLAIM

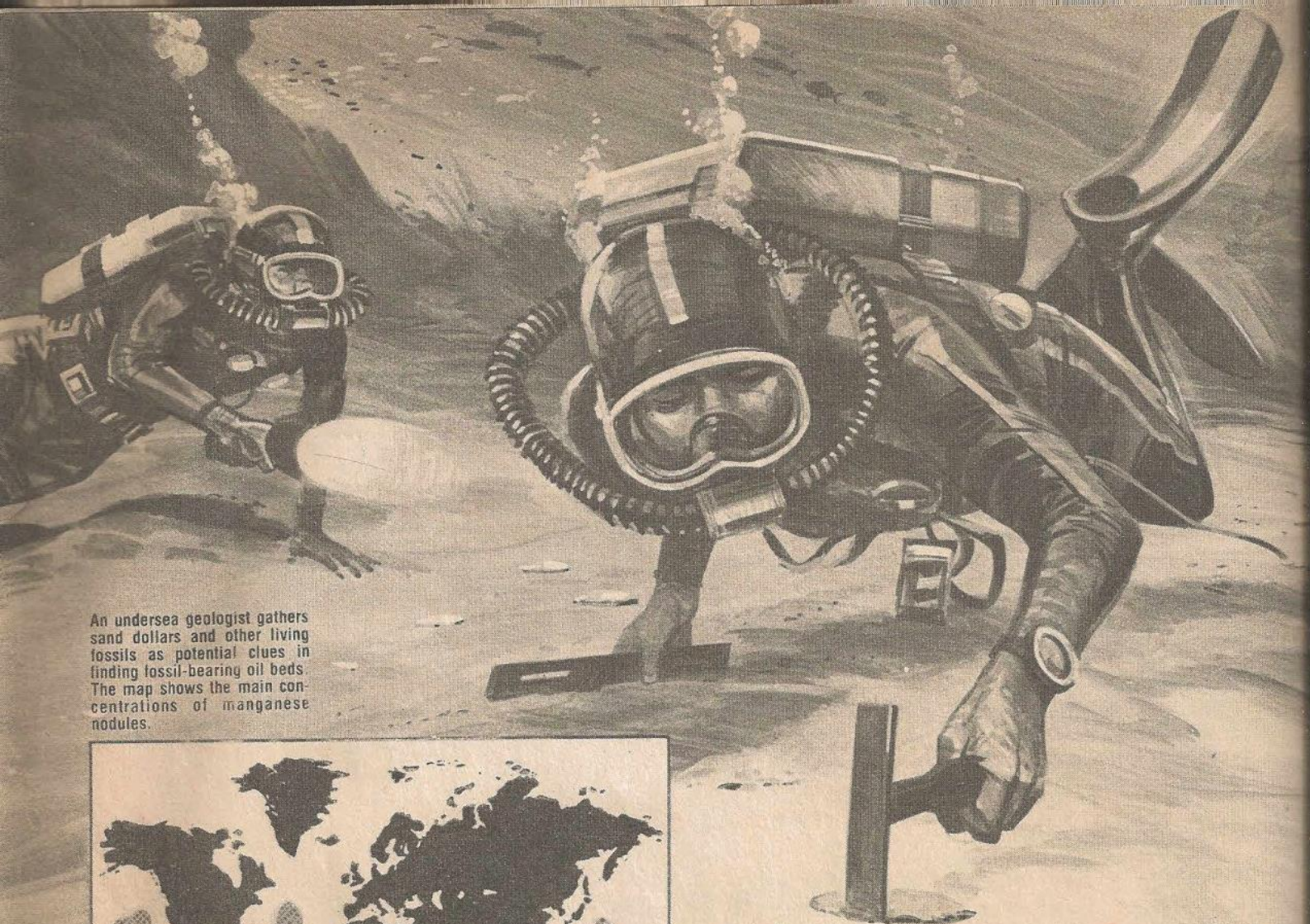
Deep Sea Miner II is believed to be capable of handling between 750 to 1,000 tons of nodules daily from an area, for which its owners lodged the first-ever

ocean mining claim in 1972.

The area, 1200 miles south-west of Los Angeles, covers about 35,000 square miles. Before setting out on their first real attempt to mine the precious nodules in quantity, the treasure-seekers tested their gear off the mouth of the Columbia River. Afterwards they set sail for Los Angeles where they took on 16,000 feet of piping. Then the big adventure began as *Deep Sea Miner II* ploughed through the Pacific waters for the chosen area. It will last for many months.

Manganese nodules are found mainly in areas where the water is rich in oxygen. The nodule beds most

CONTINUED ON NEXT PAGE



An undersea geologist gathers sand dollars and other living fossils as potential clues in finding fossil-bearing oil beds. The map shows the main concentrations of manganese nodules.



favoured for mining — those with the highest copper and nickel content — apparently lie in the Pacific south-west of Hawaii and just north of the equator where there is high biological productivity. The richest deposits occur in a narrow band, perhaps no more than 289 kilometres wide and 2,000 kilometres long, running roughly east-west around 190° at a depth of about three miles.

It was a British expedition ship, HMS *Challenger*, that first discovered nodules in 1873. But they were of no more than an academic interest for 75 years. Interest in them rose in the 1950s when University of California geologists found a large quantity of nodules containing cobalt near Tahiti.

High concentrations of nodules are also found

along the southern edge of the equatorial belt, but these, like the ones in the Atlantic and Indian Oceans, are relatively poor in copper and nickel.

WORLD DEBATE

But the vital question of legal claims to the ocean floor has aroused worldwide controversy. Britain, for instance, has already opposed the right of Deep Sea Ventures to mine the Pacific sea-bed. Indeed, the fight over who should control the vast deposits of ores beneath the seas has occupied experts from 156 nations many years in the conference halls of the United Nations in New York.

In the skyscraper block, which acts as a forum for international debates and

quarrels, the member nations of the Law of the Sea Conference will gather again this Spring to try to bring some semblance of order to the growing quest for the spoils of the oceans.

Already they have set up a body known as the International Sea-bed Authority with an operating arm called The Enterprise. The world's poorer countries want this organisation to have the sole right to exploit the sea-beds in international waters — those areas far outside the fishery zones surrounding national coastlines.

For many of the world's developing countries are veritable landlocked islands, sandwiched in the centres of continents, without any merchant fleet or navy or direct claim to maritime wealth. They do not accept that they should be unable to benefit from the sea-bed riches.

On the other hand, the United States, which is confident of leading the field in the new technology, oppose controls and argue that as they are making a risky investment in a perilous field they are entitled to eventual profits. But they are prepared to co-operate with other interested countries.

Another stumbling block has been provided by Russia, which would like to see only State-owned companies permitted to undertake the mining operations.

So reconciling the interests of the world's most powerful nations with those of developing countries and working out a system of legal controls will present a daunting task for the 1,400 delegates when they meet in New York. For the UN regards the sea-bed minerals as "the common heritage of mankind" and as such to be shared by every nation, not just the lucky ones.

SCIENCE SURVEY



Getting switched on to the sun as a source of power is the newest trend in the world of fuel economy. But in this feature we also look at other ideas which are emerging in the world of science

WHY do we bother with boilers and fires to warm our homes when the biggest, fiery furnace in our part of the universe is blazing away in the sky? With the cost of ordinary fuels constantly rising, more and more ways are being sought of turning the sun's heat into usable energy.

Solar panels are being fitted to houses to supplement the hot water system. Other panels are converting sunlight into electricity.

But the most ambitious scheme to date is the one illustrated on the right: America's space administration — NASA — is considering putting an enormous energy collector in orbit. This would be taken to a low Earth orbit by shuttle vehicles. The collector would absorb solar energy and transmit it in the form of microwaves to a receiving station on Earth, for conversion to electricity.

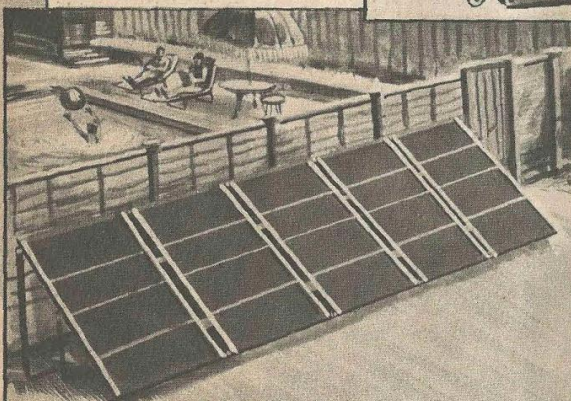
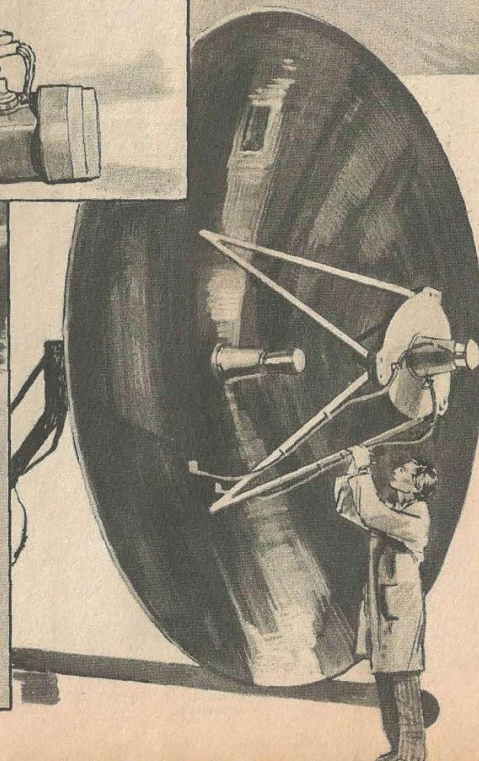
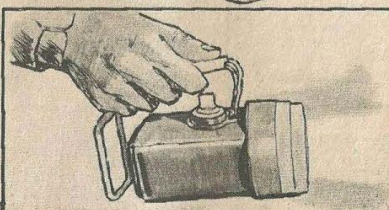
Strings of these around our globe could keep us going in that distant day when all the fossil fuels have been used up.

SUN SHOWERS FOR ALL

A hot shower that costs nothing! Take this vinyl water heater, which holds 20 pints (11 litres), and hang it on the washing line in the garden.

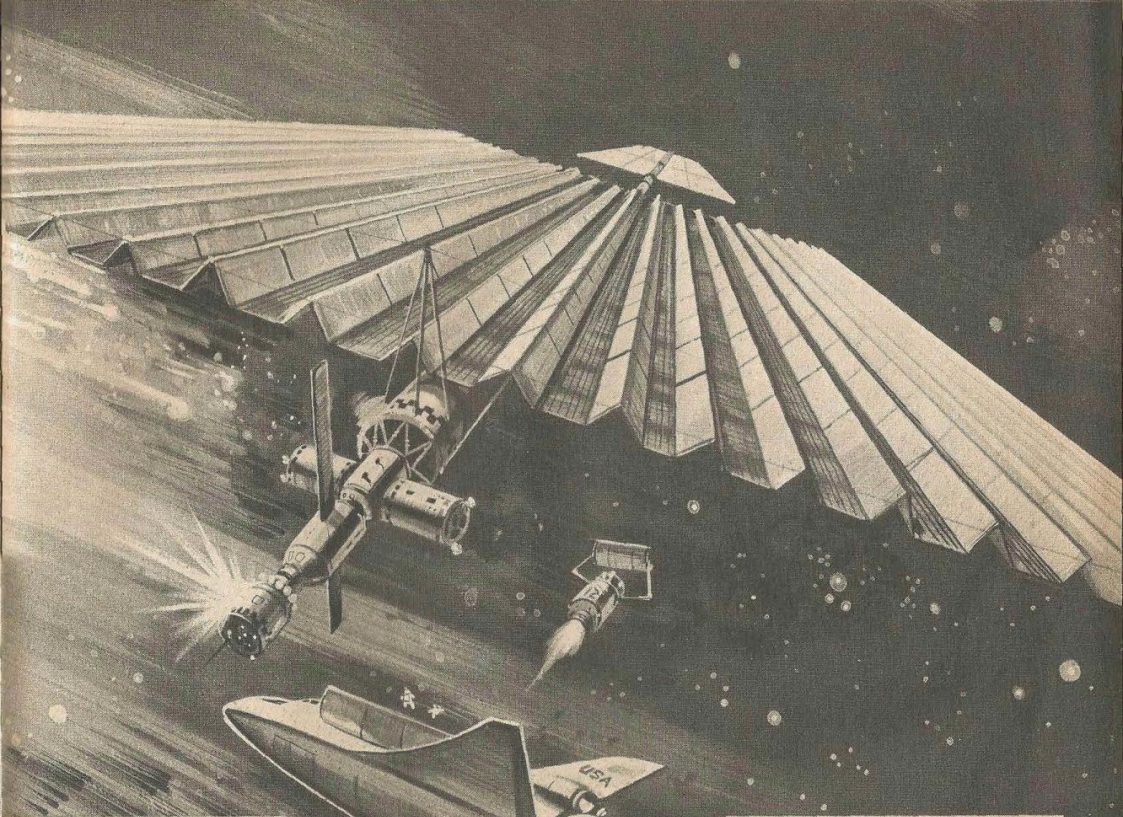
Three hours of sunshine on a 70 degrees day will take the temperature inside up to 100 degrees Fahrenheit, warm enough for a nice shower.

After free heat, how about free light? The torches on the right use a detachable solar array to charge their batteries — another bright idea



SOLAR-HEATED SWIMMERS

OUTDOOR swimming pools are notoriously costly to heat. For that reason, this solar swimming pool heater should be a boon for bathers. Using black plastic as its main material, it is designed to raise the temperature of the water to make it bearable for swimmers. From May to September, a temperature rise of 6 degrees Centigrade should be averaged.



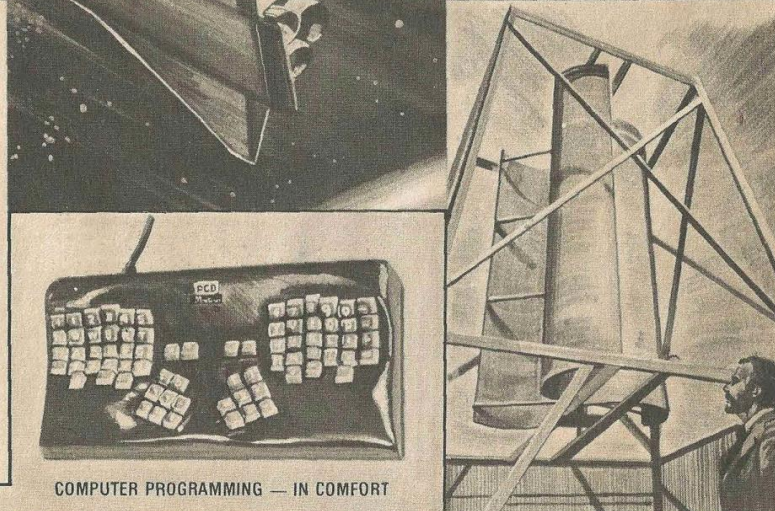
INTER-PLANETARY CONTROLLERS

FAR from the heat of the sun is the planet Saturn which is due for a fly-round by Mariner space craft in America's 1977 Jupiter/Saturn programme.

Controlling the vehicles as they hurtle through the universe will be the huge bowl aerial on the left, said to be the biggest one ever made from a special composite material. It is 12 ft. (3.66 m. in diameter).

Weighing only 45 kg (100 lb), three of these sensitive bowl aeriels will be used by NASA's jet propulsion laboratory in the Mariner programme.

Computers fed with information by radar, will point the bowl aeriels directly at the space craft.



COMPUTER PROGRAMMING — IN COMFORT

FROM the look of the keyboard above, it might seem to be something of a joke. In actual fact, it is a novel design for a keyboard for a computer, or other electronic equipment. The whole point of the keyboard is to have the keys where the fingers and thumbs

can reach them naturally. It has been designed to avoid any strain on fingers, arms and shoulders for operators who have to spend hours each day at the keyboard. The keyboard is said to speed up typing by 20 to 40 per cent and to result in fewer mistakes.

THE POWER SCOOPER

VERTICAL wind scoops spin this power-generating windmill. It is designed for city rooftops and other limited spaces where the wind is erratic. In a 12 mph (19 km/hr) wind it develops 1 hp.

215/12

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THE MODERN MEDIEVAL MAN (SEE PAGE 10)

Speed
& Power

THE PIGGY-BACK BARGE CARRIERS

Barges that can sail on canals and rivers and cross the seas on the backs or in the holds of mammoth ships are being used to speed up the flow of goods between the trading nations of the world

On their way to inland terminals are these barges being pushed along the Mississippi River in the U.S.A. by a powerful tug.

Stern elevator of the *Atlantic Forest* which lifts barges to their stowage decks. The tug shown is capable of pushing six barges to the parent ship. *Atlantic Forest* is designed to carry 73 barges stacked in two layers on its deck and in its hold.

ATLANTIC FOREST
KRISTIANSAND

BACK BARGE CARRIERS

BUSY Middle Eastern ports, crowded with ships waiting for berth space, have created a problem for cargo-carrying vessels in recent years.

In common with other ports, unable to cope with the increasing interchange of goods between countries, they have shown that drastic rethinking was called for by the ship designers.

The result of their work at the drawing board is both startling and obvious — startling because it represents a novel answer to the problem, and obvious because the best solution is often so close at hand it is frequently ignored.

What the designers produced was a vessel of great size able to carry a large number of barges. Such barges can be loaded at a dock in shallow water in about a quarter of an hour, and then towed by a tug to a waiting ship. After floating into the ship's stern well, they are then carried by a lift to the platform on which they are to be stowed.

The first of these barge carrying ships began service on the world's sea routes in 1969. So successful was this initial venture that there are now nearly 30 barge carriers plying their trade in every ocean.

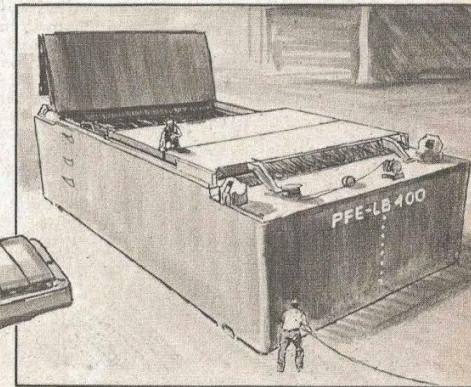
LASH (lighter aboard ship) was the name applied to this concept. Launched in 1969, the first vessel of this type was built by Japan for a Norwegian firm. Named *Acadia Forest*, it was later joined by a sister ship, *Atlan-*

tic Forest and was used to carry pulp and paper to Britain and western Europe.

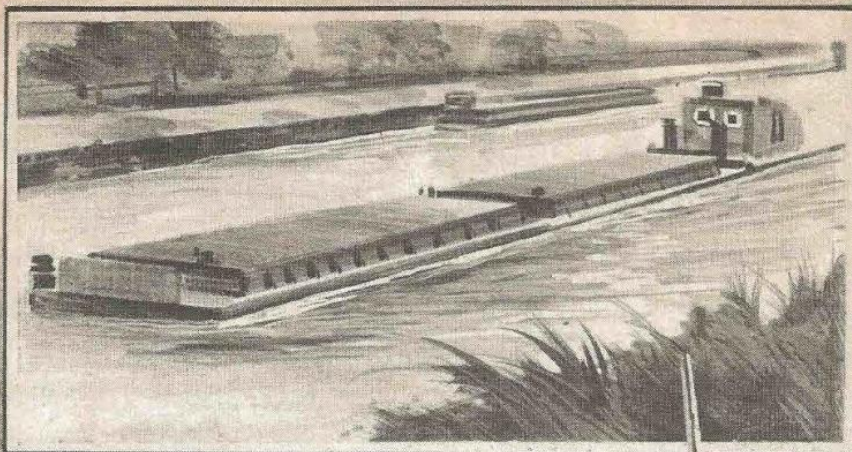
Working with these vessels were 383 LASH barges. Each vessel carried 73 barges in its hold and stacked in two layers on its deck, these being carried to their position by a massive travelling crane.

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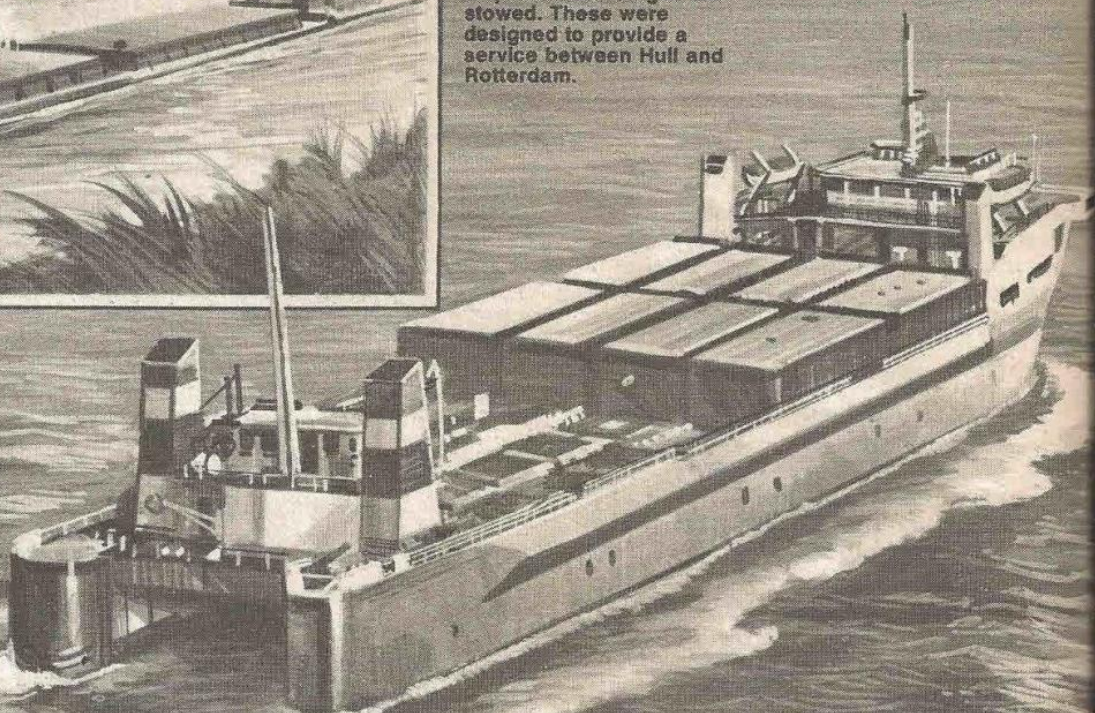
A method of loading barges on to a ship by the use of a submersible elevator at the stern is used in sea barge carriers known as Sea Bees. After the barge has been raised to its stowage deck, it is carried to its stacking position by a transporter.



One of the barges being completed at an American factory where the assembly rate is one a day. Designated LASH (lighter aboard ship), barges of this kind are used by several American companies for carrying cargoes to and from the U.S.A., the Middle East, South East Asia and Britain.



Along one of Britain's inland waterways go two BACAT (barge aboard catamaran) barges. Pushing them is a British Waterways Board tug (left). Below is a BACAT ship on which barges are stowed. These were designed to provide a service between Hull and Rotterdam.



America then came on to the scene with an order for eleven vessels and several hundred barges. Each ship can carry 74 barges (or lighters) as well as 288 cargo containers of the kind you see carried by juggernaut lorries. A large crane was installed for loading the containers.

When they are fully loaded, these ships are carrying an enormously heavy cargo. Should the cargo slide about, it could topple the ship or give it a dangerous list.

To avoid this, the lighters and containers are firmly held in place, and the ships are fitted with stabilisers to avoid rolling.

Several American companies are now using LASH ships for carrying cargoes to and from the U.S.A., Middle East, Japan, South East Asia and Britain.

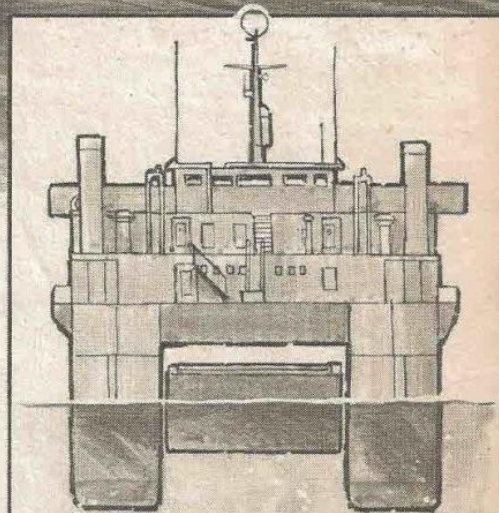
Europe came into the picture with an order for two LASH vessels each able to carry 83 barges. In the holds, 49 are stacked in four layers and on the deck 34 can be carried in two tiers. These single screw, diesel engined ships have a speed of 18 knots (about 20 mph or 32 km/hr).

All the barges carried by LASH vessels are of a standard size, the dimensions having been chosen to enable them to be used on European waterways, including those of Britain.

A method of loading barges on to a ship, by floating them on and off at the stern (mentioned at the start of this article) is incorporated in a series of ships known as Sea Bees (sea barge carriers). These have a lift at the stern which is below the water when a barge is floated over it. The lift then rises to carry the barge to any one of three decks. It is then stowed by a transporter.

Under the barge decks are vast tanks for carrying oil, so the Sea Bee could, in wartime, carry military vehicles as well as fuel for them. The routes link America and Europe, and Ireland received its first visit from a Sea Bee when one arrived in Dublin Bay and deposited barges there.

A similar idea was worked out for linking Britain's waterways with those of the Continent. A vessel named BACAT (barge aboard catamaran) was devised by a Danish ship owner. It was to run between Hull and Rotterdam.

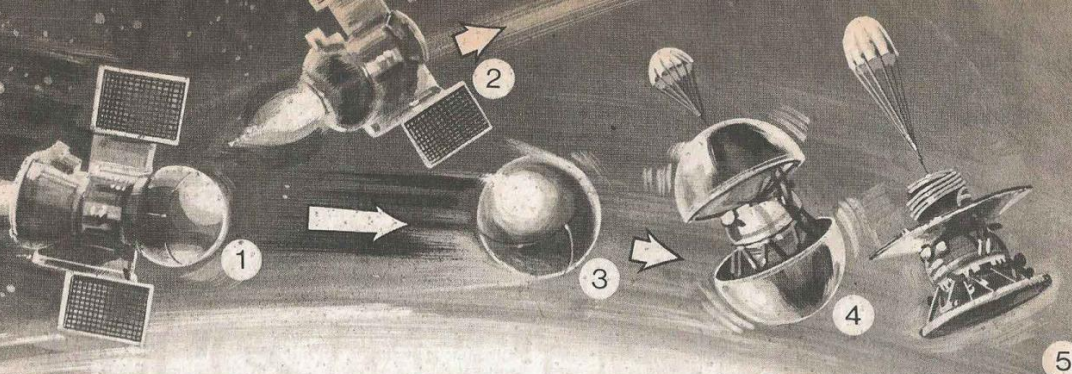


This diagram shows the twin hulls of *Bacat 1*, which was able to carry ten barges on its weather deck and three stowed between the hulls, as shown in this diagram. An elevator platform lifted barges to the weather deck, where they were placed on trolleys and moved by winches to their stowage positions.

From these ports, the barges were to be pushed by tugs to inland destinations on canals and navigable rivers.

Our illustrations show the form these vessels were to take. The first was *Bacat 1* which was used for a few years and then came out of service after opposition from dockers.

But generally, such vessels have been welcomed as a means of speeding up trade throughout the world and of keeping the life blood of commerce flowing.



SECRETS OF THE HIDDEN PLANET

VENUS is the mystery planet of the universe. Since the era of the 17th century astronomer Galileo, men have tried to discover its secrets. But they have always been thwarted by the fact that this planet is covered with a thick layer of clouds.

Modern science, however, is at last beginning to succeed where men with their optical telescopes have failed. Radio telescopes have penetrated the cloud cover and revealed Venusian hills.

American Mariner spacecraft have flown by Venus and picked up facts about this planet, which is our nearest neighbour in space and moves in an orbit which places it between the Earth and Mercury.

But the greatest discoveries of all have been made by two Russian vehicles. These landed on Venus from their mother craft, which went into orbit around the planet.

Russia's Venus space programme began in February, 1966, when Venera 2 and 3 reached Venus. Radio contact with these was lost. Venera 4, which followed in October, 1967, was a little more successful. It was transmitting all the time it was approaching the planet. Even before it crashed on the surface, the tremendous pressure of the Venusian atmosphere had caved in its instrument panel.

Progress was made when Venera 5 and 6 made soft landings. Then, in December, 1970, came Venera 7, which landed and transmitted for half-an-hour.

Landings by Venera 8, 9 and 10 produced some startlingly spectacular results. Not only did they give the world its first photographs of the surface of Venus, but the scientific apparatus carried by the landing modules provided an analysis of the atmosphere and the constitution of the soil.

Behind its veil of clouds, Venus has for long been a planet of mystery. Space probes from Russia, however, have landed on the planet's surface and made many surprising discoveries

These provided confirmation, if such were needed, that there are no men on Venus. It was already known that Venus is a world similar in size to the Earth, close to the sun, and moving in a nearly circular orbit. However, it takes 243 Earth days to make one rotation.

Even if men could withstand the great heat — the surface is constantly above the boiling point of water so there is no water on Venus — they would have another problem to face. This is the pressure of the atmosphere which is about a hundred times that of the Earth's. In addition, Venus has no seasons and is always covered by its clouds which sail through the sky at a great speed.

It is in the composition of these clouds that scientists are most interested. These are composed mainly of concentrated sulphuric acid with a very small quantity of water vapour.

Venus's air is nearly all carbon dioxide (97 per cent) with small concentrations of nitrogen, oxygen and argon.

The reason that the atmosphere and the clouds are so composed is the planet's intense heat. In fact, the sur-

face is so hot that it is constantly releasing sulphuric, hydrochloric and other acids into the atmosphere.

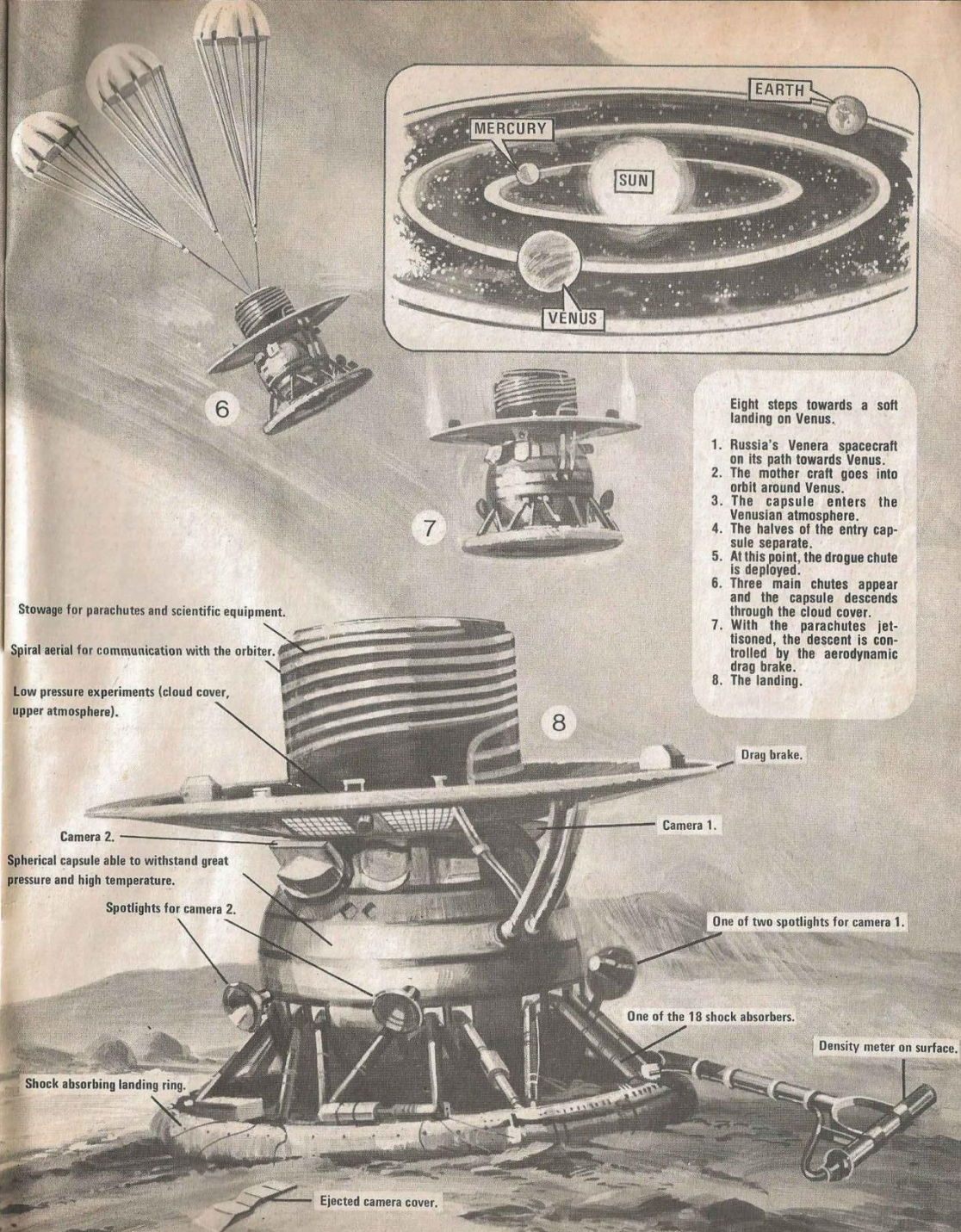
This heat also has another strange effect. It keeps the surface sufficiently plastic to prevent mountains being built because the rocks would not be able to maintain their height in such conditions.

With height, however, the temperature falls off, as does the density of the atmosphere and the pressure.

Scientists had thought that Venus would be in a permanent shade. Venera 8, 9 and 10 all landed in areas where the light was very bright. This was good enough to enable Venera 9 and 10 to take some very clear pictures of the planet.

These revealed a rocky surface composed of stones so tough that there is very little erosion. First to land was Venera 9 which came down on a steep slope near rocks and cliffs. Three days later, Venera 10 descended on the flat surface of an outcrop of layered rock. Obeying radio commands from Earth, these landers took samples of the soil and the atmosphere, and transmitted streams of information back to our planet. Their cameras were also busy, recording for the first time the appearance of the rock-strewn surface.

Undoubtedly, more visits will be made to Venus until eventually our enigmatic neighbour in space, is a mystery planet no longer.



Eight steps towards a soft landing on Venus.

1. Russia's Venera spacecraft on its path towards Venus.
2. The mother craft goes into orbit around Venus.
3. The capsule enters the Venusian atmosphere.
4. The halves of the entry capsule separate.
5. At this point, the drogue chute is deployed.
6. Three main chutes appear and the capsule descends through the cloud cover.
7. With the parachutes jettisoned, the descent is controlled by the aerodynamic drag brake.
8. The landing.

Stowage for parachutes and scientific equipment.

Spiral aerial for communication with the orbiter.

Low pressure experiments (cloud cover, upper atmosphere).

Camera 2.

Spherical capsule able to withstand great pressure and high temperature.

Spotlights for camera 2.

Camera 1.

One of two spotlights for camera 1.

One of the 18 shock absorbers.

Density meter on surface.

Shock absorbing landing ring.

Ejected camera cover.

Speed
6-Power

215/2

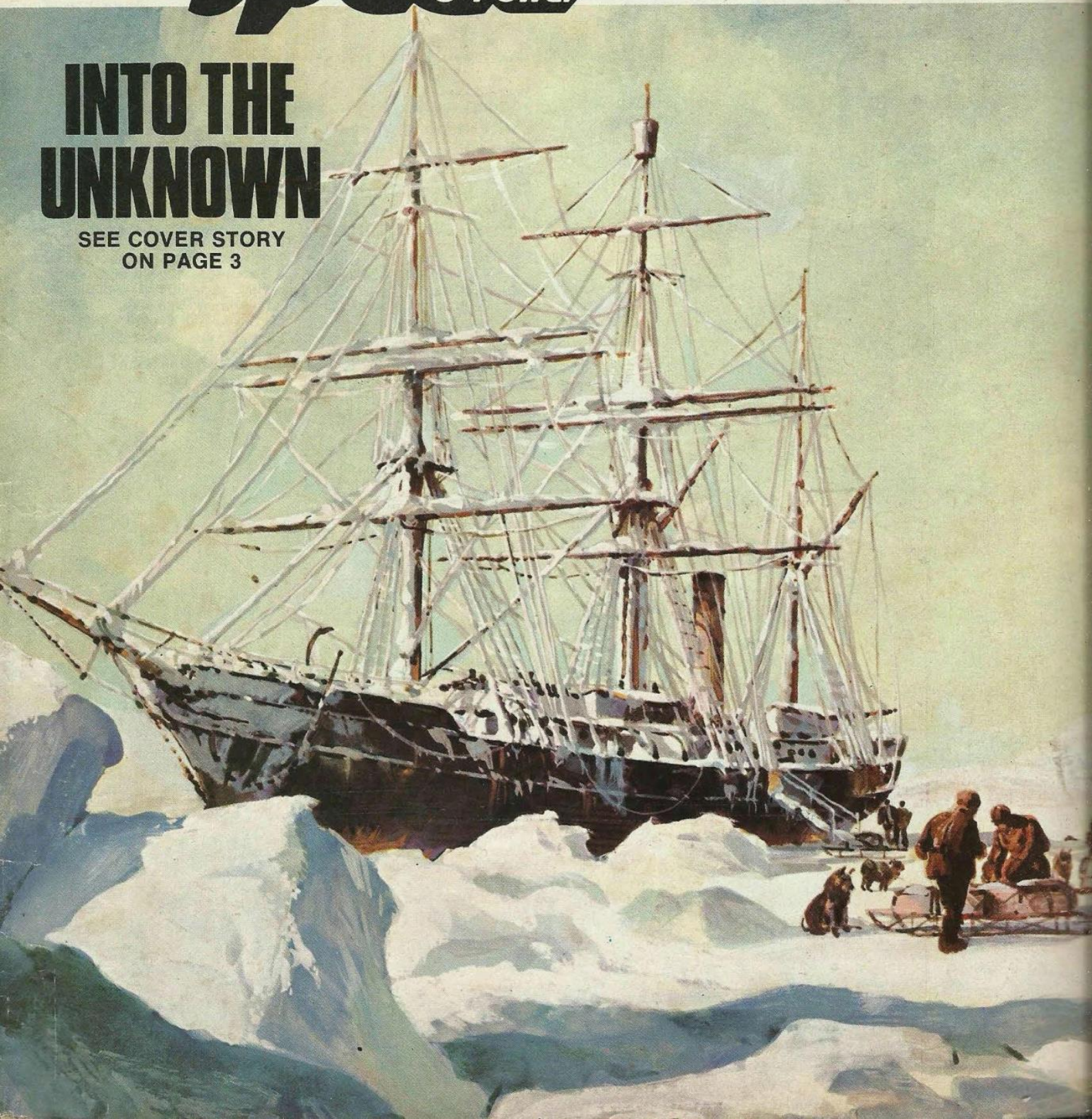
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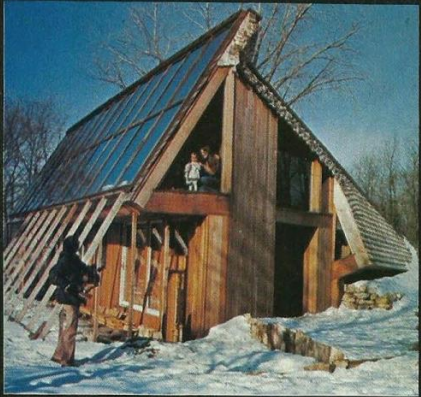
INTO THE UNKNOWN

SEE COVER STORY
ON PAGE 3

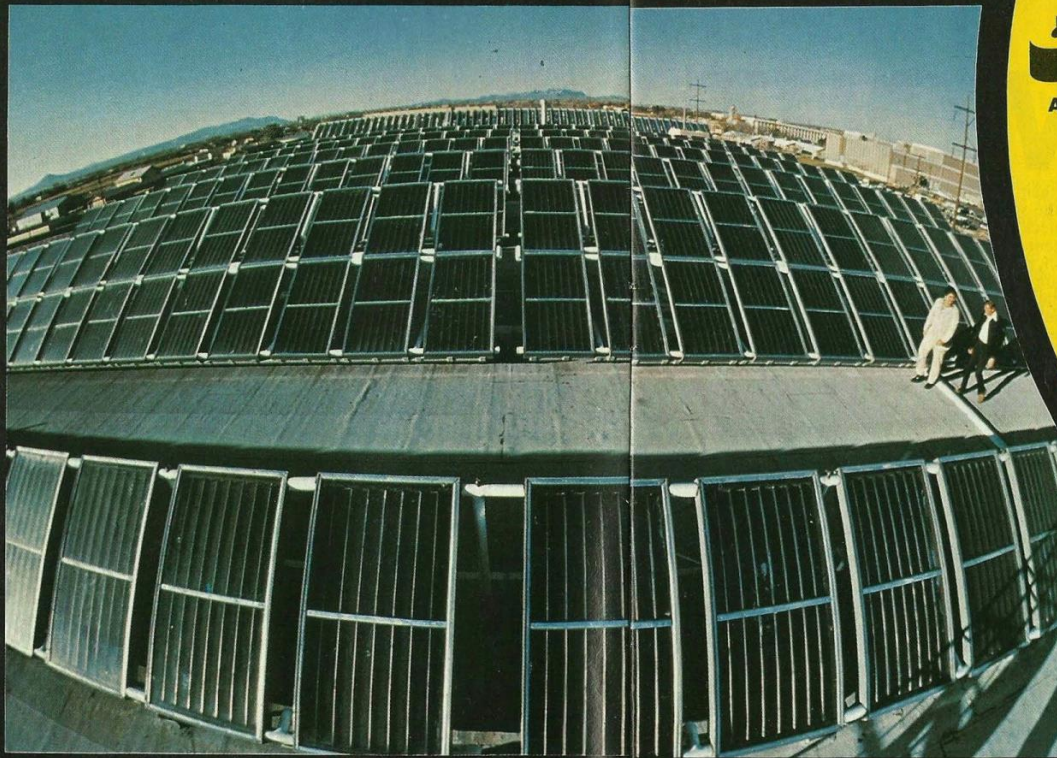
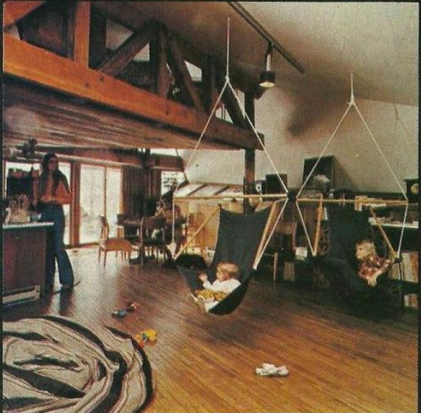




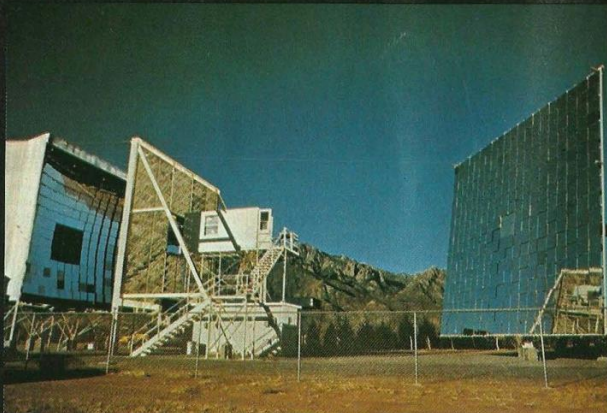
Fluid circulating through solar panels on the roof of an American girls' school heats water which, in turn, warms the school, greenhouse and swimming pool.



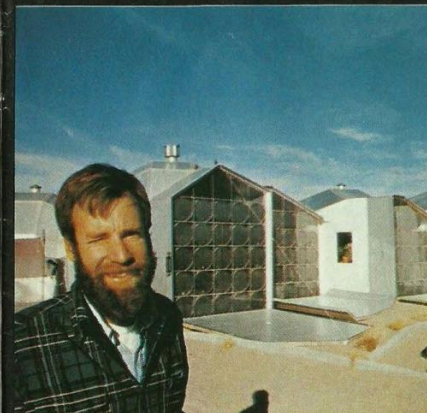
The south wall of a house on which panels are filled with water to collect and hold heat (above). A solar installation, claimed to be the world's largest, heats the school below.



A vast array of panels on this building collects the sun's heat and feeds it into a furnace. This has already been used to melt tungsten and to test boilers for power-generating plant. Below is a house built at an American university as a laboratory for experiments in making a self-sufficient home. It uses a water collector for solar-heating, a windmill for electricity-generation and battery storage. Students wanted to find ways of harnessing solar power because it produces neither pollution nor radio-activity. It is inexhaustible, though diffuse and difficult to collect.



Solar heating installations at an American office building (below). More and more offices are likely to follow this example since the U.S. government is allocating increased funds for solar-energy research. Enormous areas have to be covered with solar panels to collect the sun's heat, as can be seen by comparing the men with the panels on the right. Electricity from solar cells cost from fifty to a hundred times as much as that produced by conventional means.



SUN TRAPS

ARE THEY THE SOLUTION TO MAN'S ENERGY PROBLEMS?

FROM Land's End to John o' Groats, in villages and towns, more and more people are seeking ways of capturing the sun's radiation for heating purposes. Although the current cost of turning sunlight into energy makes it uncompetitive with the more conventional fuels, there is no doubt that solar power is slowly coming of age.

Panels which convert sunlight into electricity and others which warm water circulating through them have been successfully fitted in Britain.

The sun's energy is being trapped in many ways. In America, systems which work more like ordinary gas or oil heating arrangements are becoming popular. Fans force the heated air through ducts to cylinders filled with rocky material that holds the heat. When warmth is needed, air from the rooms is circulated through the material and directed into the heating ducts.

Other systems use water or various anti-freeze solutions as the heat conducting medium. The heated medium circulates through a coil over which air is blown by a fan and ducted to every room in the house.

Light sensitive cells which generate an electric current when the sun shines on them have an application on the solar heating scene, although they are expensive.

A better way of making electricity is in a solar furnace in which hundreds of mirrors direct sunlight on to one central furnace. In this, water is heated to make steam for a turbine that could produce enough electricity to supply a town of up to 10,000 people.

Apart from the cost of solar schemes, there are two main problems to be solved. Engineers have to find more efficient ways of storing heat from the sun and of tapping solar energy for power production without filling huge tracts of land with reflectors or photo-voltaic cells.

These problems must be solved, for the Earth's supplies of coal, oil and gas are not limitless.

And long after they have been used up, the sun's power will still be ripe for harvesting.



SCIENCE SURVEY

This week's review of what's new includes an aeroplane-boat, a TV driver's "mirror" and a scheme that has overcome neck rot - in onions

A CASSETTE IN HAND...

Ever seen a man sitting in a train talking into the palm of his hand? Bet you thought he was crazy. He was probably dictating a letter to his secretary, using a palm-sized recorder that takes a cassette of tape about as big as a book of matches.

Such recorders are not suited to recording music but they are excellent for businessmen, students and travellers who want to make a sound diary.

Music comes out best on wider and faster tape. To provide this, some Japanese firms are now selling in America cassettes slightly smaller than a paperback book. Although their sound quality is as good as that of a reel-to-reel deck, the cassettes are dear and the decks on which they are played could cost up to £1,000. Of course, you could economise on a £500 model.

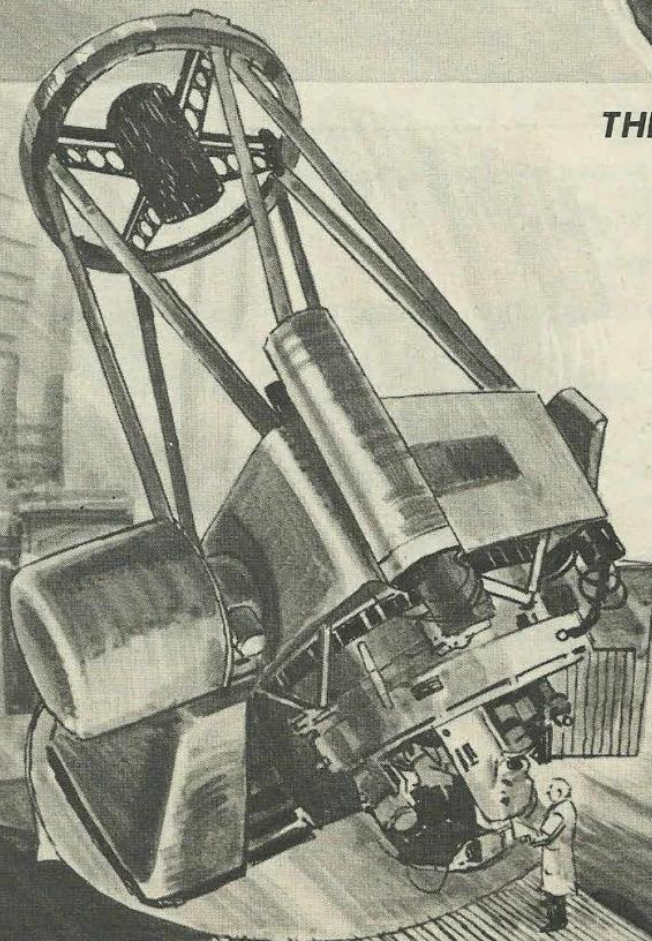


THE TRAVELLING TELESCOPE

Britain's largest optical telescope is being prepared for a move to clearer skies.

It is at the Royal Greenwich Observatory at Herstmonceux in Sussex.

If negotiations between Britain and Spain are satisfactory, the telescope will go to Palma in the Canary Islands off the north west coast of Africa where it is hoped to set up the Northern Hemisphere Observatory.



GETTING IT IN THE NECK

Seventeen years ago, Britain imported over 90 per cent of the onions it ate. Since then, the National Vegetable Research Station has found ways of boosting our onion production so that we now grow half of the crops we need.

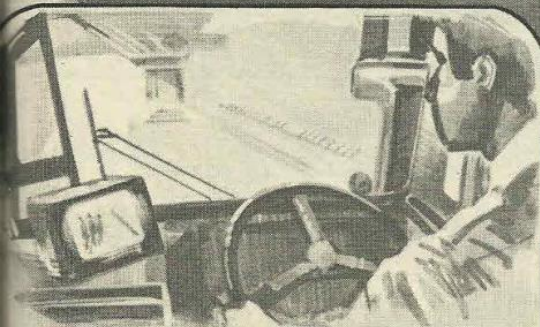
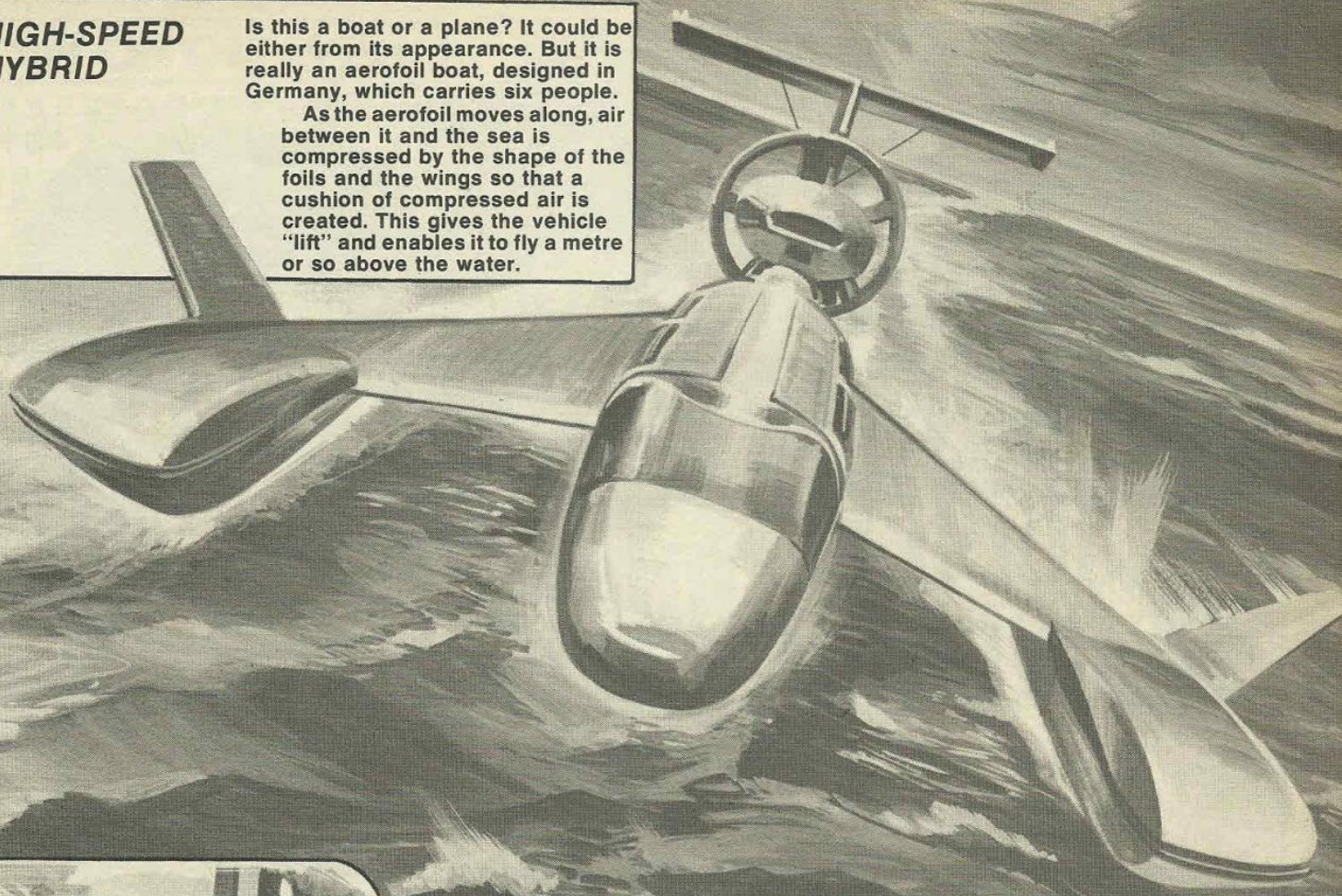
This was achieved by controlling disease during storage and by extending the cropping season. Neck rot was the main onion killer, and this was beaten by the use of a special soil dressing when the seed was sown.

The result: bigger and bigger crops of healthy onions.

HIGH-SPEED HYBRID

Is this a boat or a plane? It could be either from its appearance. But it is really an aerofoil boat, designed in Germany, which carries six people.

As the aerofoil moves along, air between it and the sea is compressed by the shape of the foils and the wings so that a cushion of compressed air is created. This gives the vehicle "lift" and enables it to fly a metre or so above the water.



MOBILE TV - TOKYO-STYLE

Bus drivers in Tokyo, Japan, running between the airport and hotels used to have trouble in seeing the following traffic through their rear-view mirrors.

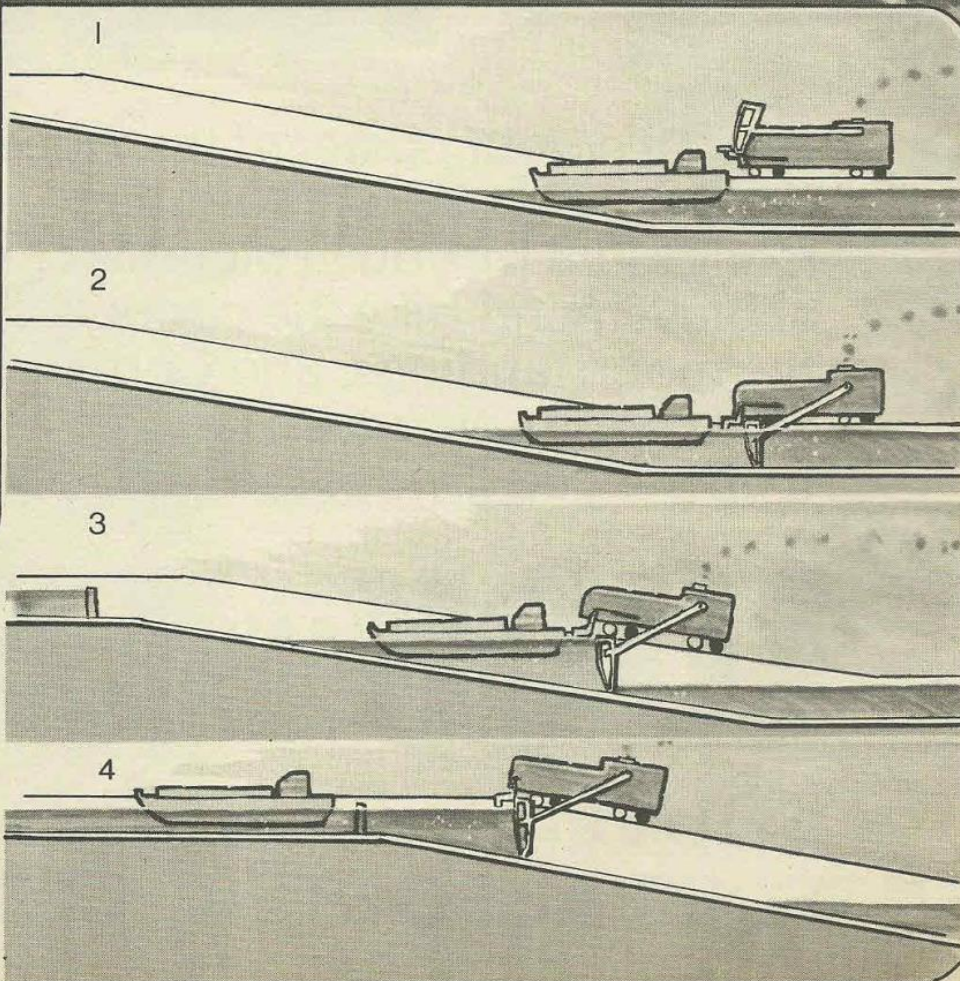
In electronically-minded Japan there was only one way out of this: a TV camera mounted on the rear of the bus and a screen beside the driver. Now, he just has to switch on his TV to see what's coming.

AN UPHILL RIDE - BY BOAT

To move a ship from lower to higher water usually requires a system of locks and gates with many people to open and close them.

Now look at the pictures on the right to see how the difficulty is being overcome in France.

A vessel approaches a specially made slope. Behind it a sliding plate is lowered. This plate and the water are propelled by two diesel-electric locomotives, one on each side of the waterway. With them goes the boat, free to continue its journey.



EYES UNDER THE OCEAN

Television cameras attached to unmanned mini-submarines and deep sea divers' helmets are enabling technicians above the sea's surface to search underwater oil installations for faults and to direct maintenance work

UNDERWATER television is not a particularly new idea. In fact it dates back twenty-five years or more to when it was used as an aid to salvage operations in water too deep for divers to operate in.

It was an early underwater TV camera which enabled the Royal Navy to find the wreck of a British Comet jet airliner which crashed in 1954 in the Mediterranean.

The equipment used by the Navy was a Marconi Siebe-Gorman camera, which was the only one available that was fitted with a remote-controlled periscope eyepiece. Although it was remarkable for its time, it was a huge and unwieldy piece of equipment compared with the incredibly compact under-

water TV cameras used today.

Without modern underwater TV, the work of maintaining and repairing off-shore oil drilling rigs would be much more difficult, particularly in conditions as cold and as rough as those found in the North Sea. An American company have designed and built a TV camera that can be lowered down inside a drill pipe so that joints, seals and other vital parts of the system can be examined in detail.

The heart of this amazing piece of electronic engineering is a long, slim TV camera which fits on to the end of a telescope tube. A battery-powered lighting collar is fitted round the lower end of the drill pipe to provide illumination, so that the

camera can capture details the human eye cannot see.

On the deck of the rig, the operator controls the descent of the camera from a special console and watches the pictures it sends back on a viewing screen. If any faults are found, drilling can be brought to a halt while repairs are carried out.

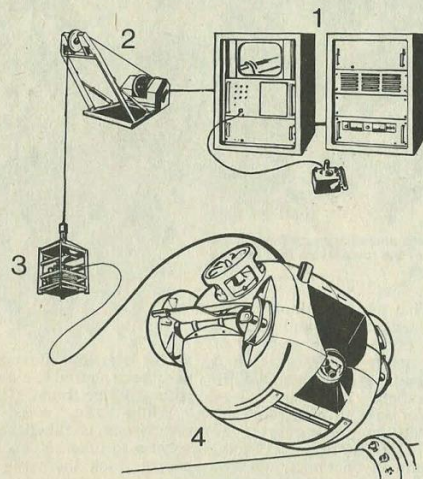
Another even more remarkable miniature television camera is manufactured by the same American company. The camera is so small and compact that it can be fitted to the top of a diver's helmet. It can be removed by the diver while he is underwater and hand-held so that he can direct it at any object within arm's length. The lens can be focused by remote control to view objects at long

or short range.

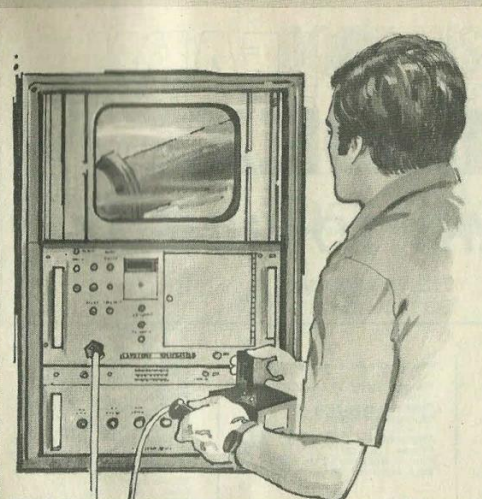
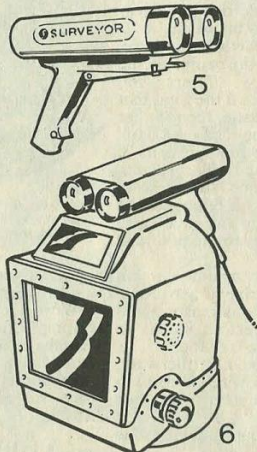
The unit also includes a powerful tungsten halogen light mounted alongside the camera. While the unit remains clamped to the diver's helmet, the watchers on the surface can see what the underwater camera-man is viewing. As he is also in telephone contact with them, they can ask him to give them a close-up of any particular object, such as a pipeline valve, or the blades of a ship's propeller.

Apart from its television screen, the control console has a loudspeaker, and the operator can also switch-in both a video and sound recording tape. A sequence, video taped by the

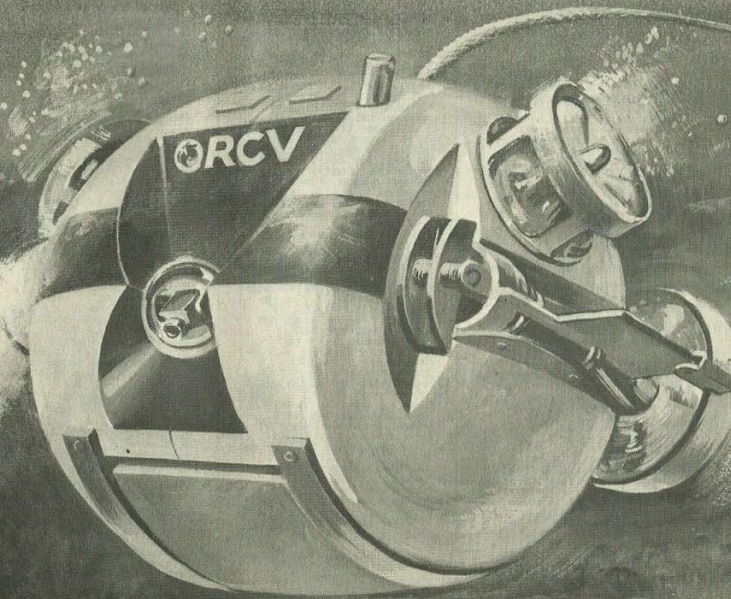
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The various units of the remote controlled underwater inspection vehicle are shown on the left. They are, in the anti-clockwise direction: 1 - The surface control console. 2 - Winch. 3 - Launcher. 4 - The vehicle itself, attached by its tether cable. Shown in the diagrams on the right is: 5 - Miniature TV camera which can be used underwater clamped to the deep sea diver's helmet (6).



Sitting at his control console, the operator can see on a TV screen a clear picture of the ocean bed. With his controls and displays, he can govern the depth of the mini-submarine, as on the right, direct it to wherever he wishes and record what it "sees" on videotape for later study. He would be stationed in the ship, above, right. The cage shape (right) is the launcher from which the mini-sub is released on cable played out by a winch.



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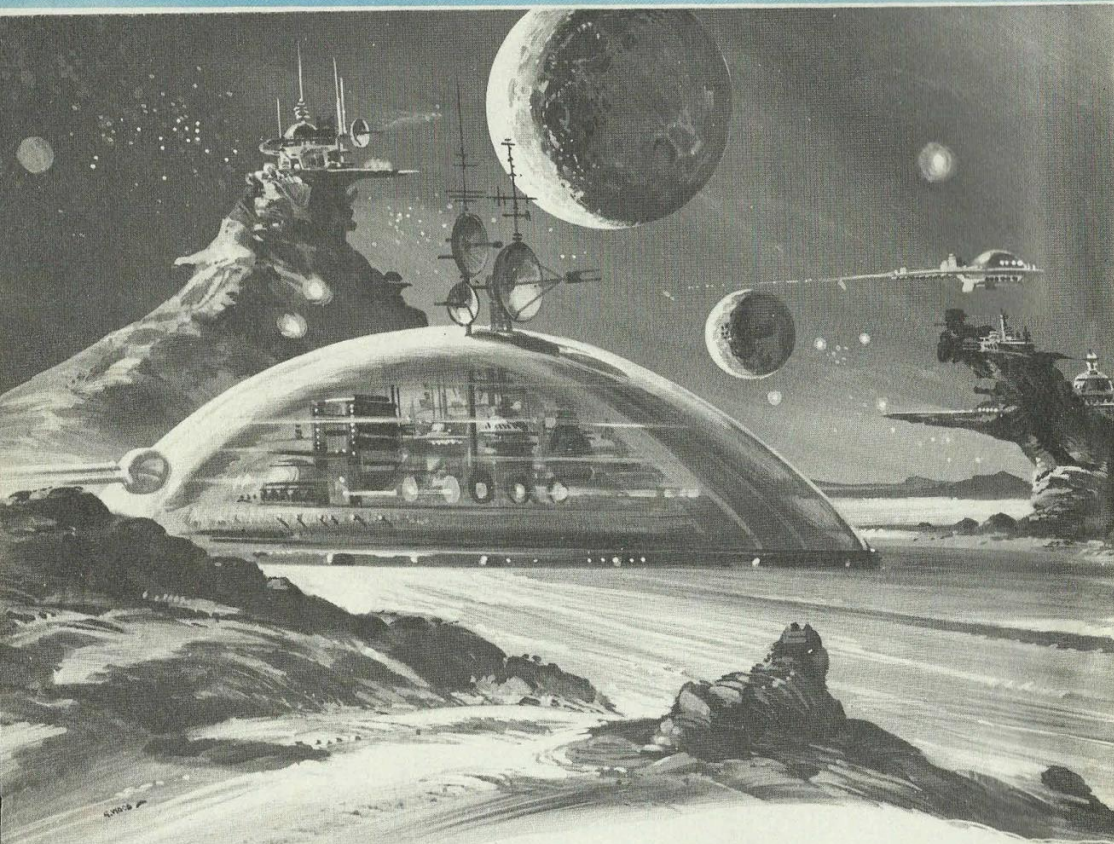
CALLING ALL STARS

Read inside how radio
astronomers are searching for life
on other planets



No. 810 23rd July, 1977
IPC MAGAZINES LTD., KING'S REACH TOWER,
STAMFORD STREET, LONDON SE1 9LS
Telephone: 01-261 5000

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CALLING ALL STARS

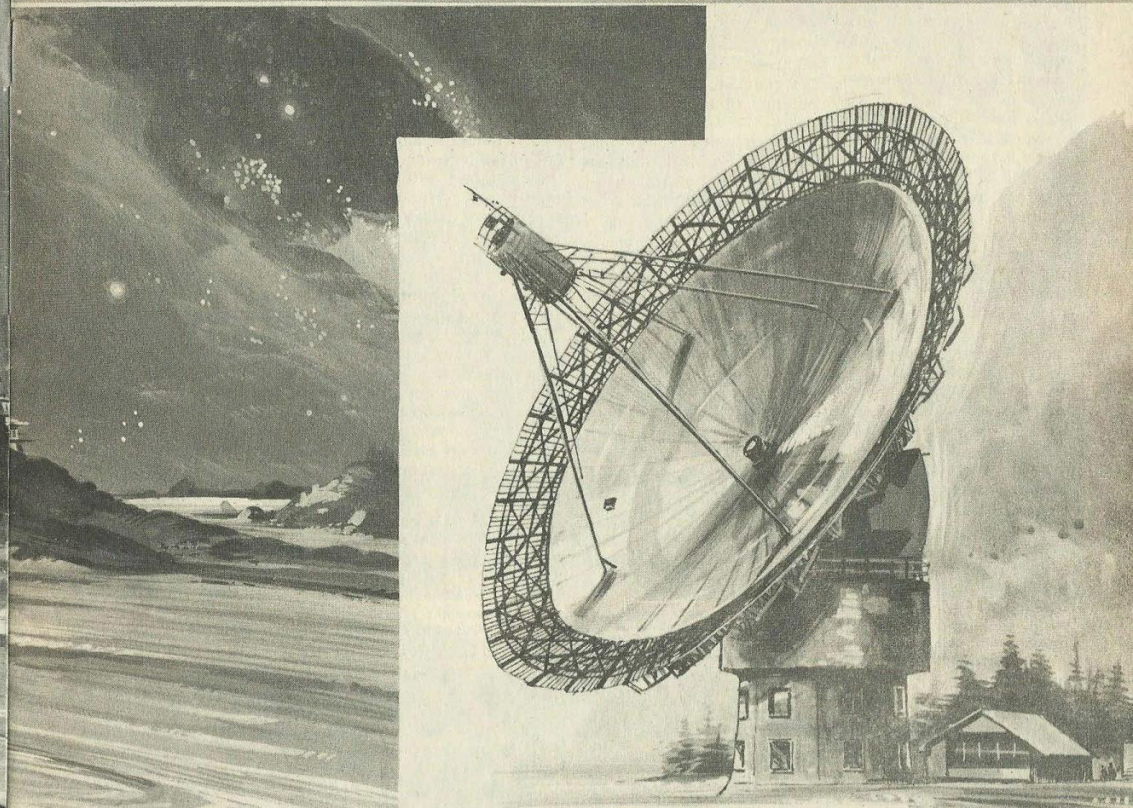
On another world, in another galaxy, there is life... life as intelligent or more so than our own. This is the belief of radio astronomers who are exploring the universe in the hope that a message from an extra-terrestrial being will one day come crackling into their headphones

COVER STORY

Of all the mysteries which have intrigued us, none holds out more exciting prospects than that of discovering whether there is life elsewhere in the universe. A determined effort to solve this puzzle is being made by radio astronomers who are directing their aerials at distant galaxies in the strong belief that some day they will receive a message from a distant planet. Read about their researches on these pages.



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About 500 sun-like stars are having their solar systems searched for signs of life by this great radio telescope, the Algonquin, in Canada. One day its operators may contact a distant planet. But will it be like the one on the left?

SOMEWHERE, an astronomer with headphones clamped to his ears will hear something. It may be a bleep, a buzz or even a whispered word that has winged its way across millions of miles of space. And it will signal a breakthrough — a startling revelation — in the history of the universe. For it will prove

that on another world, in another galaxy, there is life... life as intelligent or more so than our own. When this great day will come nobody knows. But its arrival is eagerly awaited by scientists who are maintaining an intense listening watch for any sign of intelligence in outer space. Over a wide range of

wavelengths and with targets that vary from nearby stars to distant galaxies, the radio astronomers are conducting their search with hope in their hearts. For there is a growing belief that life elsewhere in the universe could be more common than has been supposed.

At a conference in

Armenia, on extra-terrestrial life, Russian and American scientists suggested that in our galaxy alone there could be as many as one million advanced civilisations. They reached this total after working out the probable number of planetary systems in the galaxy. From this they deduced that life was

CONTINUED ON NEXT PAGE▶

likely not only to exist but to reach an advanced level on some of these planets, and that this was likely to have some means of communicating with us.

Only one star out of many thousands may have within its orbit a world capable of supporting life. And as there are many millions of stars in our galaxy, the radio astronomers will have to be very painstaking in their search. However, there is every chance that, in the end, their efforts will be crowned with success.

The listening programme began in 1960, when a scientist at an observatory in West Virginia, U.S.A., turned his radio telescope on to the two nearest stars most like our own sun. After logging a total of 150 listening hours, he was without result.

A more powerful telescope has since been installed. With this, there has been a search of ten nearby stars, including Tau Ceti, Epsilon Eridani and Barnard's star. The latter is the second closest star to us and it is believed to have a planetary system.

Suppose that there is life somewhere out in space and that it takes the form of a being able to build and operate a radio transmitter, what wavelength would it use?

It appears that the astronomers regard two wavelengths as possibilities. Most of them favour 21 centimetres and are hopefully staying tuned to that frequency.

Others think that distant broadcasters in our galaxy might be sending out signals on 1.35 centimetres and are pointing aerials linked to this band at distant worlds.

Canada's Algonquin radio telescope is making a search on 1.35 cm. It began in 1974 by focusing on 13 stars, and eventually its operators hope to have tuned in to 500 stars that are like our sun. The more stars they listen to, the greater are their chances of hearing a distant voice calling from an unseen world.

Fifty galaxies are to be

At a conference on extra-terrestrial life, scientists suggested that in our galaxy there could be as many as one million advanced civilisations. Among these could there be — somewhere — a race with radio equipment capable of transmitting messages to Earth?

explored by a radio telescope in Puerto Rico manned by American astronomers from Virginia. Their search will be on 21 cm. When these astronomers point their telescope at distant galaxies they will bring millions of stars into their beam.

By listening simultaneously to such an enormous number of stars, they increase considerably their chance of picking up a transmission.

Other astronomers elsewhere are also keeping their radio ears turned to the universe. America's space administration even launched a satellite carrying a telescope to study the ultraviolet spectra of stars. One of the reasons for this is that some astronomers believe that ultraviolet lasers

ion million miles) ... an unfathomable distance to our earthly imaginations. They would thus survey about 100,000 stars.

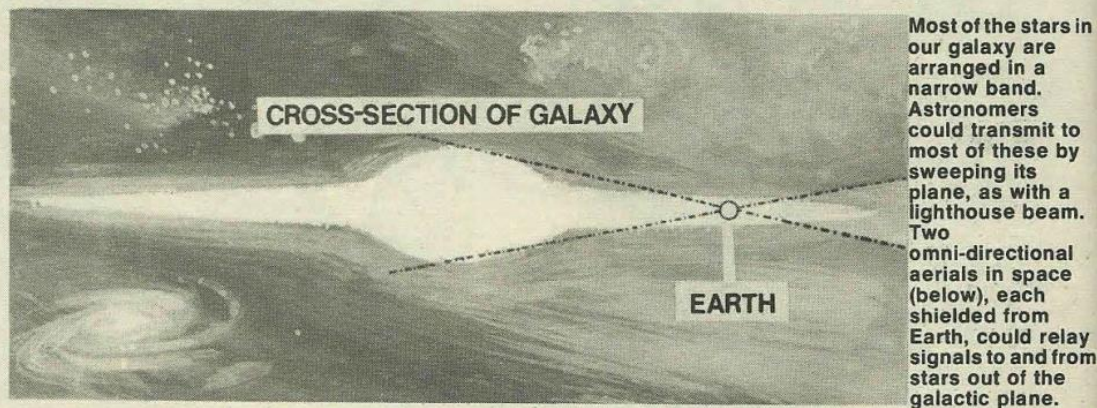
While the Americans have been racing ahead with their space listening project, the Russians have not been far behind. They have found eleven sun-type stars about 60 light years away, to which they listened without success on 30 cm. The Andromeda galaxy was also scanned in case somewhere in this great star system there might be a race of highly intelligent people transmitting with equipment of such great power that their signals would be able to reach Earth.

As a further step, the Russians have set up a network of aerials to listen for signals from the stars on 50, 30 and

16 centimetres. Monitoring is being done by eight ground stations and two satellites.

But what if the people in the other worlds are not transmitting at all but listening, just as we are? Could that explain the stalemate situation?

Obviously, we should be sending out signals for other worlds to detect. Already, the telescope in Puerto Rico is powerful enough to send signals that could reach right across our entire galaxy. Each hemisphere could have its own transmitter regularly sweeping the galactic plane. Anyone elsewhere in space within beam of transmission could switch on his own beam on the same wavelength and send back a reply. One day it will surely happen.

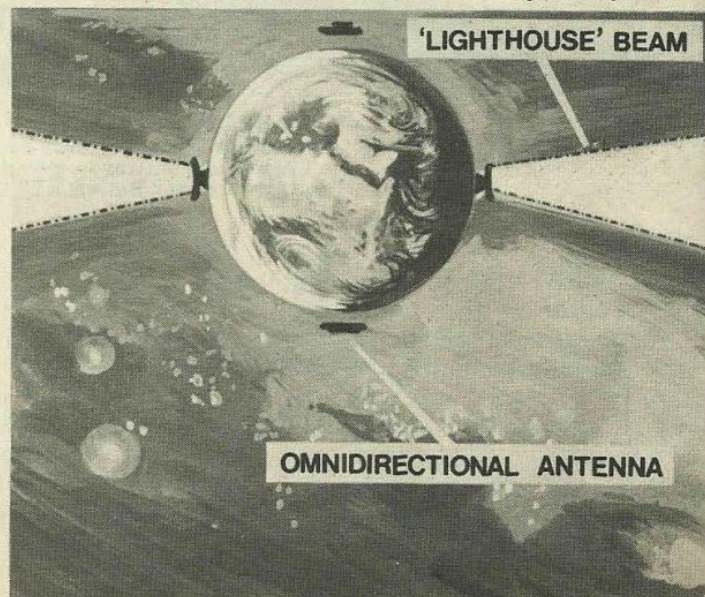


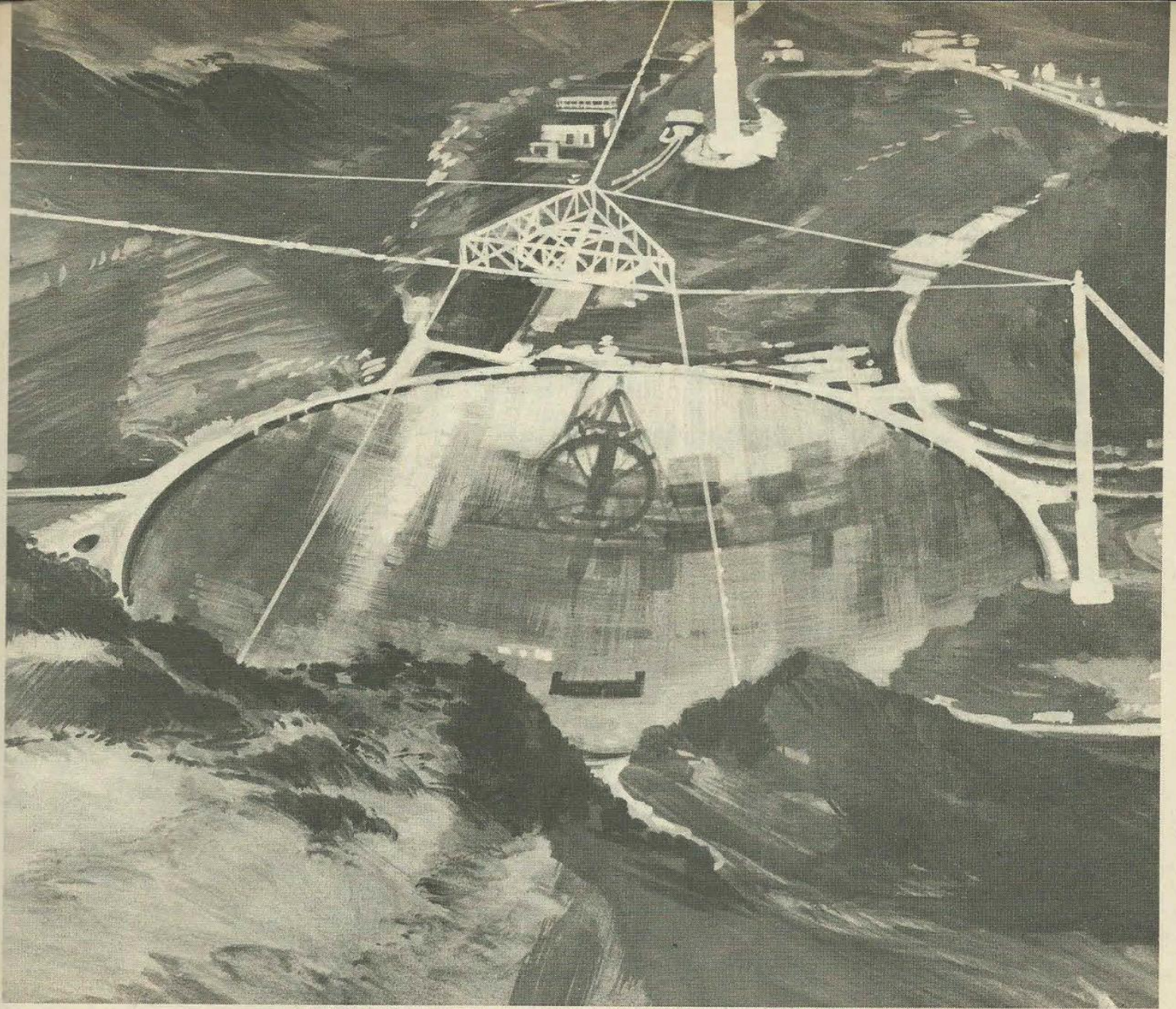
could be an efficient way of signalling between the distant worlds.

Equipment sensitive to these invisible rays would be used to detect any such transmissions.

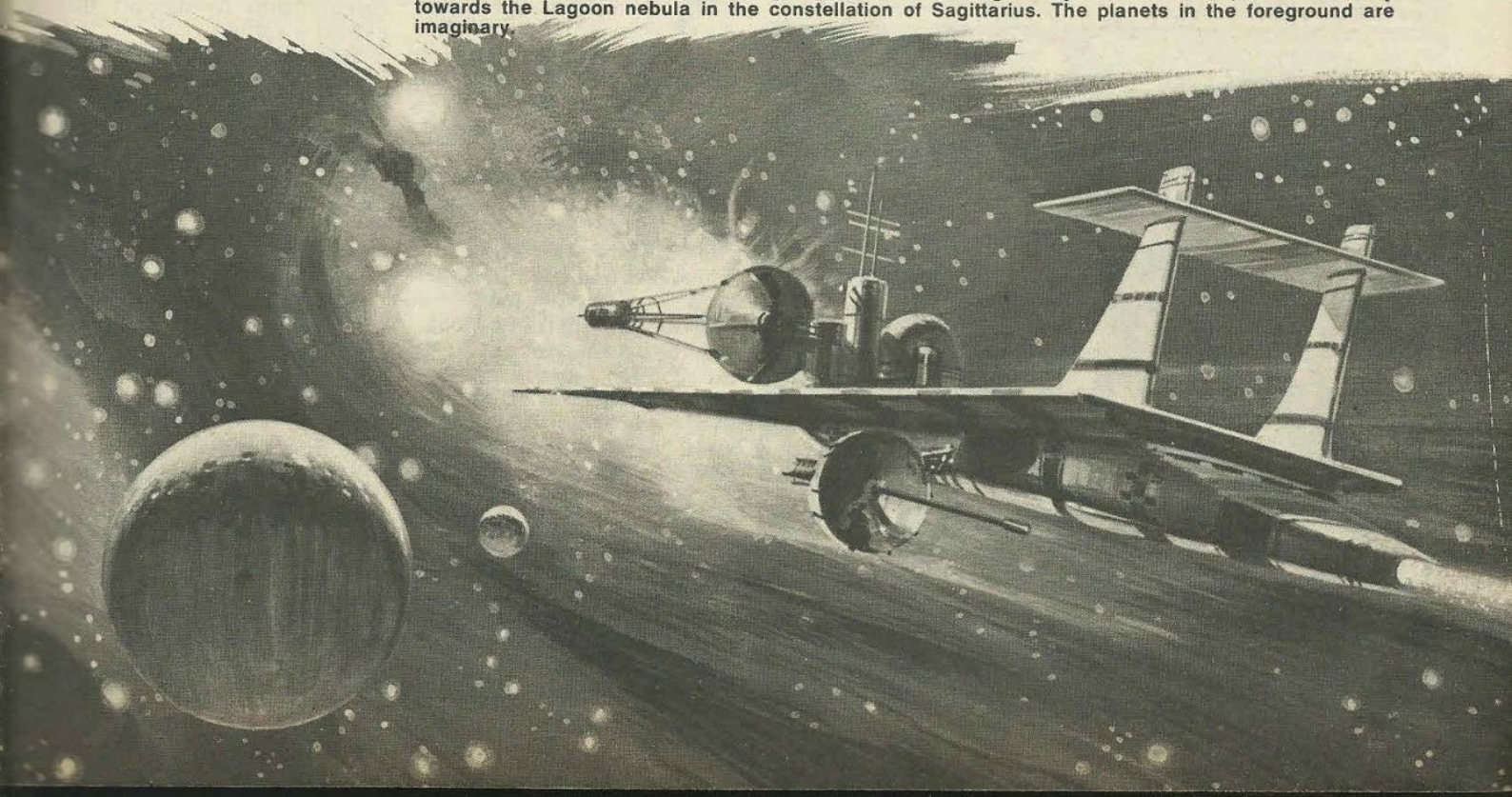
However, despite all these keen electronic ears in tune with the universe, no messages have yet been received. This lack of results does not dismay the radio astronomers who know that they have a vast area to probe.

Some feel that they may have to explore as far as a thousand light years (a light year is the distance light travels in a year — 5.88 mill-





So powerful is this radio telescope on the West Indian island of Puerto Rico that ten million stars are capable of being explored by its electronic ears. If life is detected on another planet, how will it be explored? Perhaps by an automated probe like the one imagined by our artist below, seen on its way towards the Lagoon nebula in the constellation of Sagittarius. The planets in the foreground are imaginary.



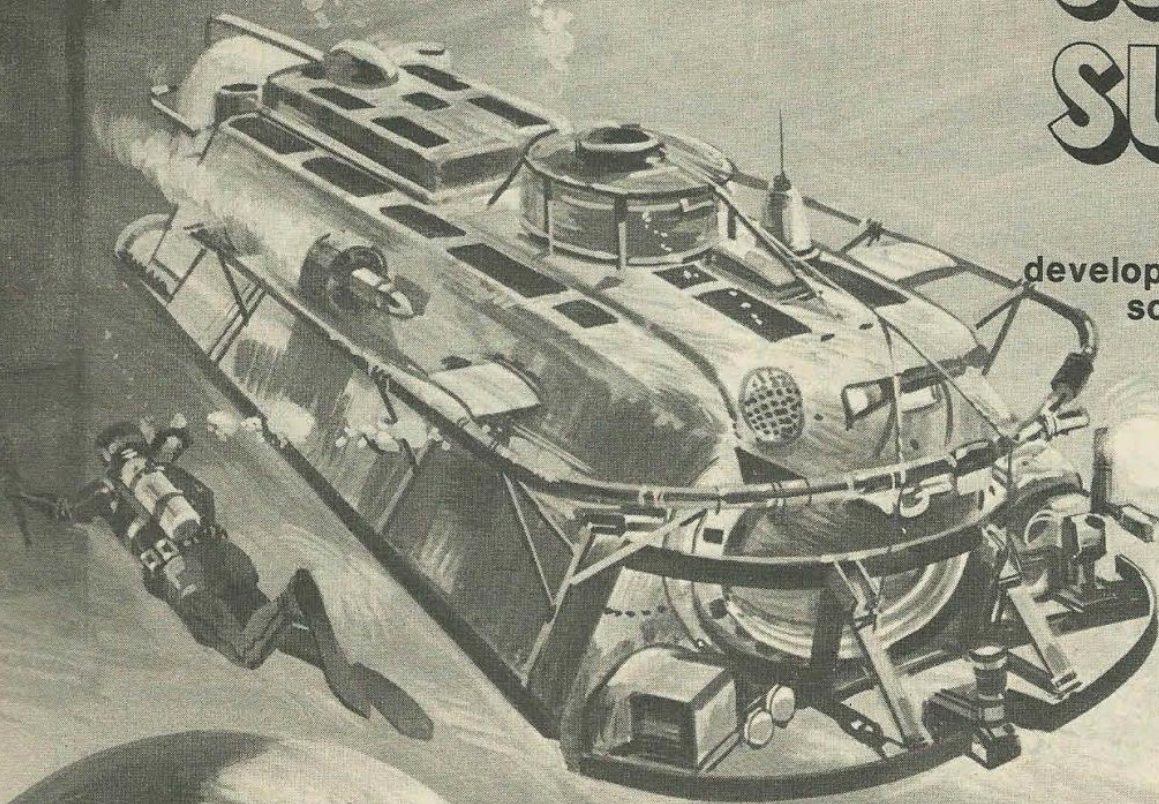
SCIENCE SURVEY

A look at some new developments in the world of science and invention

THE UNDERSEA SENSATION

A diver with a plastic submarine? Astonished? Probably you are. But the plastic of which the small submersible on the left has been made is very tough and is glass-reinforced.

Designed and made in Yorkshire, this vessel is to be operated in the North Sea where it can be used for maintenance work on oil rigs. Several resins were used in the construction of the hull which retains its strength although cables pass through it. This is a "breakthrough" in undersea work.



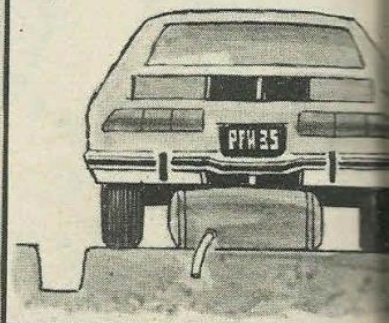
1



2



3



BLOW-UP CURES A BLOW-OUT

A blow-out — or flat tyre — means a blow-up in Japan, where a new kind of vehicle jack has been invented. It consists of a nylon bag with a one-way valve. This is connected by a tube to the car's exhaust.

When the engine is revved up, gas goes into the bag and blows it up. This raises the car so that a wheel can be changed. For this purpose, the bag is placed under the chassis near the wheel. Should the car's wheels stick in a ditch, as above, the bag is placed under the centre of the car with a fold in one side. When the bag is inflated, it stands upright, but with a tilt to one side so that it takes the car away from the ditch.

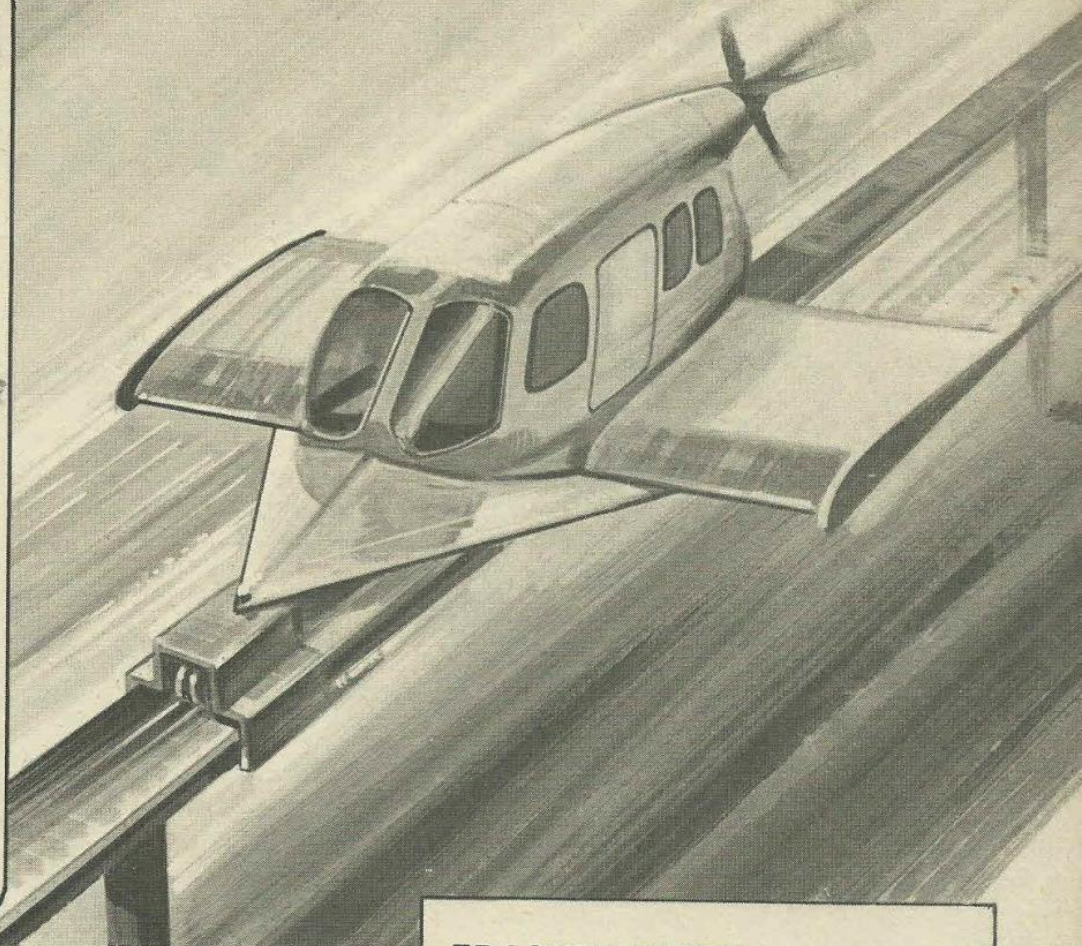
MYSTERY OF THE MARTIAN MOON

Craters layered with dust and rubble have been found on the moon. Not our moon, but on a little moon that sheds a ghostly grey light on Mars. It was photographed by America's Viking I orbiter and is called Phobos. The pictures show mysterious grooves running in parallel on the surface. These must have been made by stresses in the moon's surface. But what of the craters? Scientists think these must have been caused by gas pouring through cracks. Incidentally, spacemen have not visited Mars, although we show them in our picture. But in the future . . . who knows?



PLASTIC CLOUDS, BUT REAL RAIN

Rain is being brought to the parched sands of the Sahara by the use of plastic clouds. These are double-sided and black on the top so that they absorb heat. By soaking up the sun's rays, they inflate and rise. Hot, humid air rising from the desert condenses on the cool underside and falls as rain. Prototypes launched in the Sahara successfully produced rain and suggested the way in which deserts may be irrigated in the future.



TRACKED FLYER

Stubby wings and a pusher propeller do not necessarily add up to an aeroplane. Neither does a ball and socket joint connected to a carriage which slides on rollers along a single T-section guide rail make a monorail train.

But put these two things together and you have the vehicle shown in our picture. Designed in Germany, where it is still on the drawing board, it will fly on a cushion of air along a route defined by the rail. When it has stopped, its undercarriage will be supported by the rail. In this way, a relatively unskilled pilot could fly smoothly and on course, unaffected by crosswinds and following all the curves in the track.



HOPE FOR THE SUFFERING

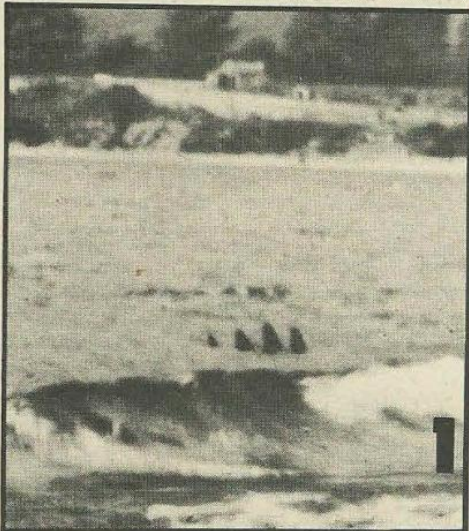
"Hope" is the name of the ship and hope is what it brings to sick and handicapped people in the under-developed parts of the world. For this is a hospital ship run by an American charity called Project Hope whose purpose is to bring medical attention to people — over half of the world's population — who normally never see a doctor.

Mystery of the Loch



If there is a photographer around when the Loch Ness monster surfaces, the man behind the lens could be Frank Searle who has spent thousands of hours at the lake waiting to take the close-up picture which will prove that the legend is a fact.

Photograph by Patrick Lichfield



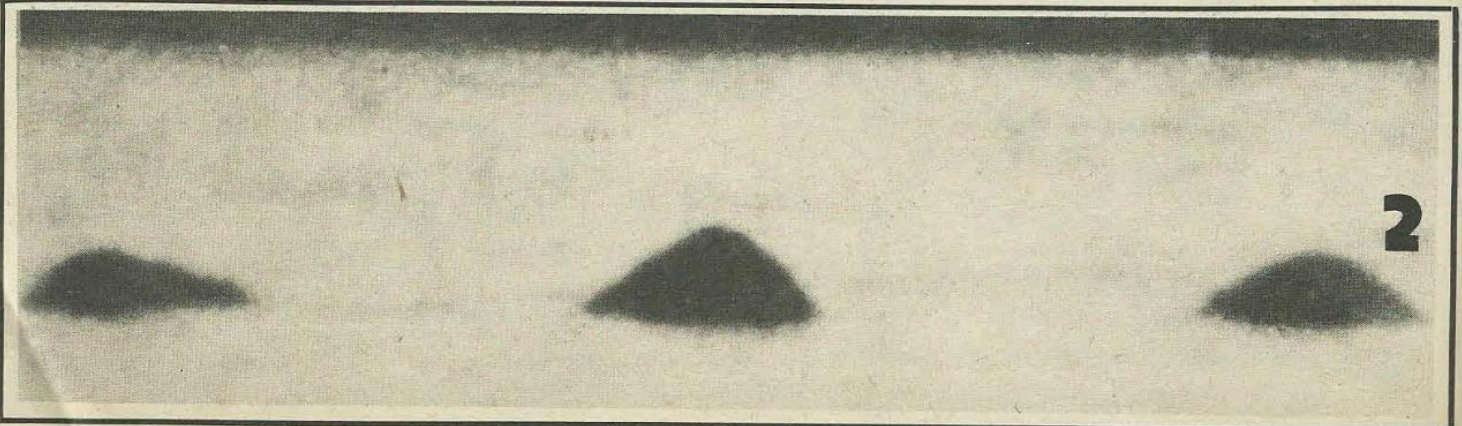
GENERATIONS of crofters in the Scottish Highlands have passed on to their children stories about one of the most intriguing mysteries of the age — about the great beasts or water kelpies which are supposed to live in the lochs.

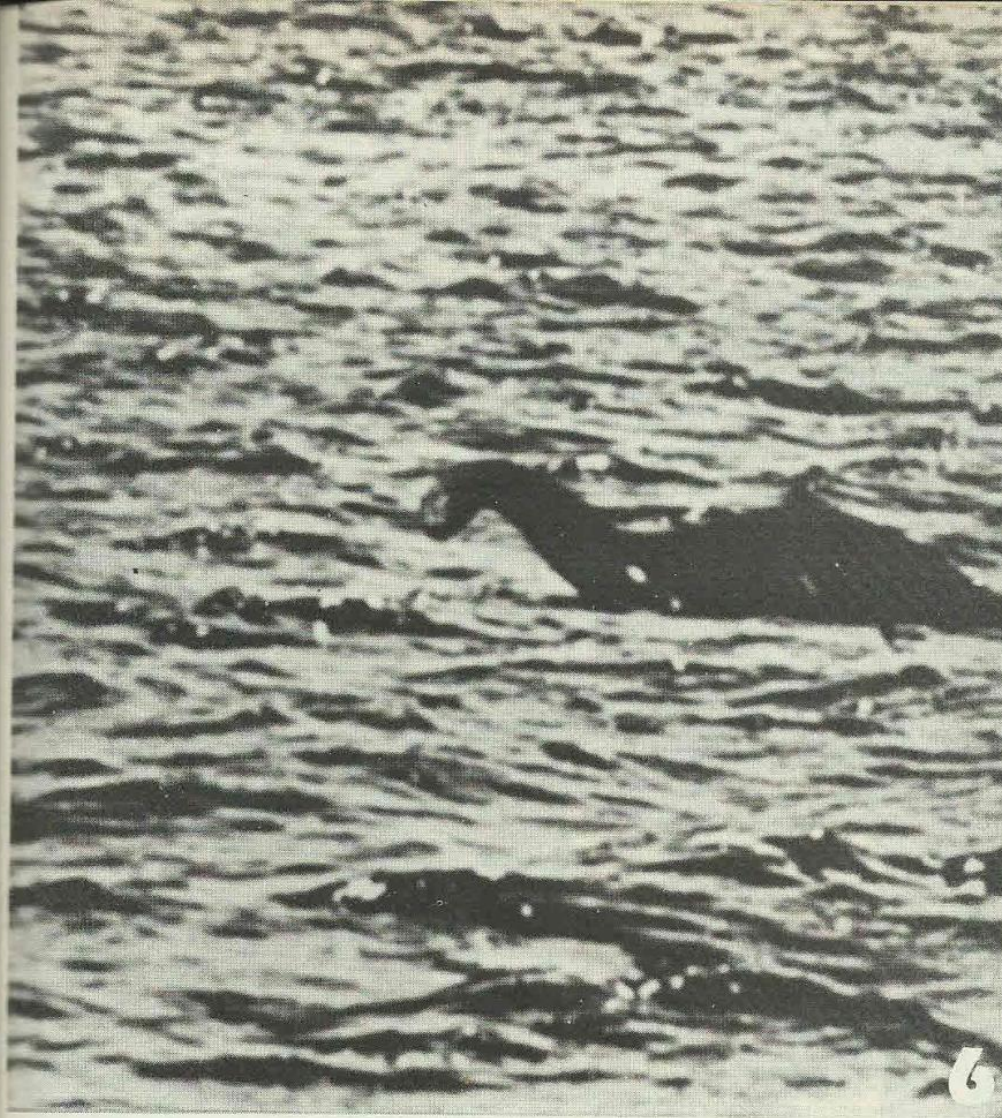
And the strangest of all these creatures is one that, legend says, lives in an enormous lake called Loch Ness.

Once an inlet of the sea, Loch Ness became an inland lake when, over millions of years, the land rose and cut it off from the

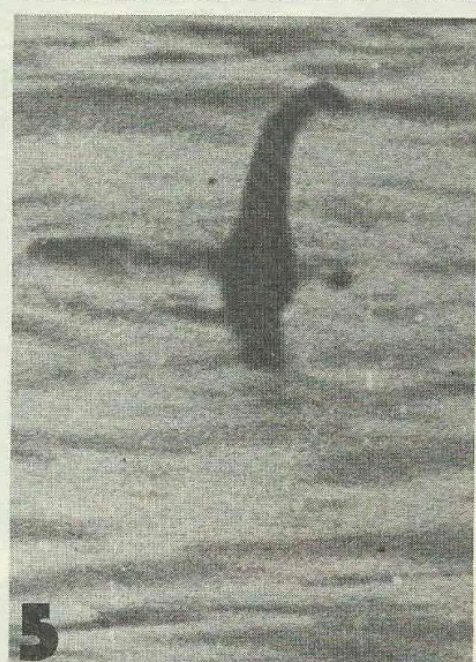
sea. Sea creatures, trapped in the loch, were forced to remain and breed there. Stories of these have given rise to the legend of the monster which many people, over the years, have claimed to have seen. Their fleeting glimpses have not removed the mystery from Scotland's most famous monster.

Such photographic evidence as has been obtained is very inconclusive. We present some of it here so that you can be the judge. Is the monster fact... or a myth?





6



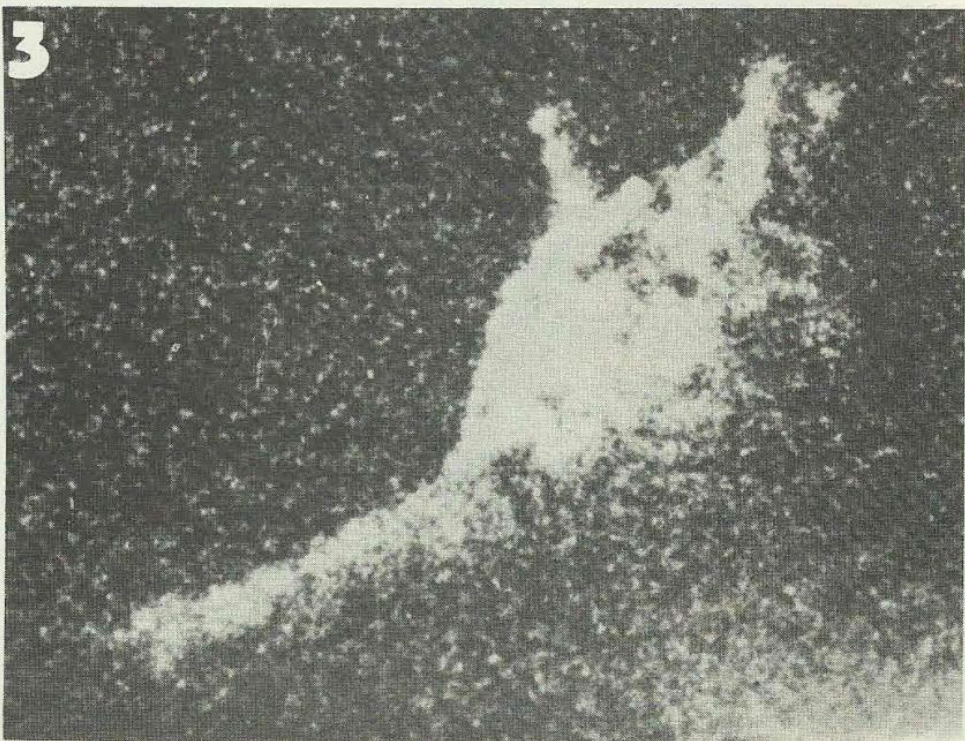
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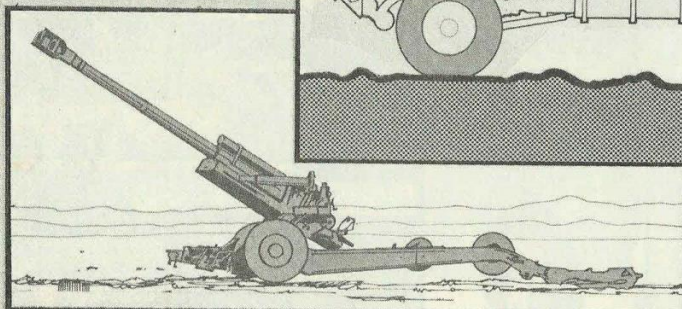
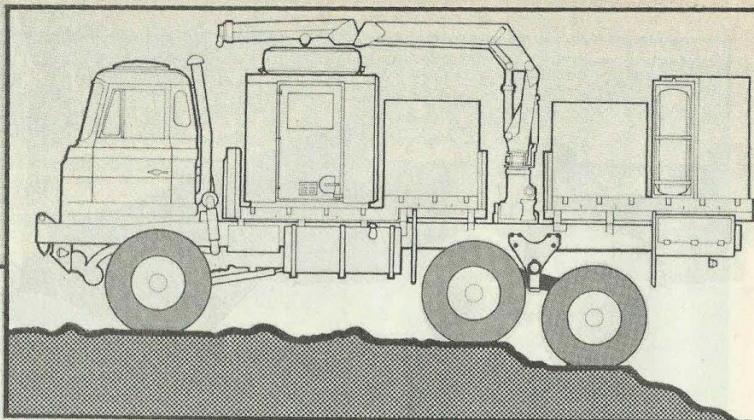


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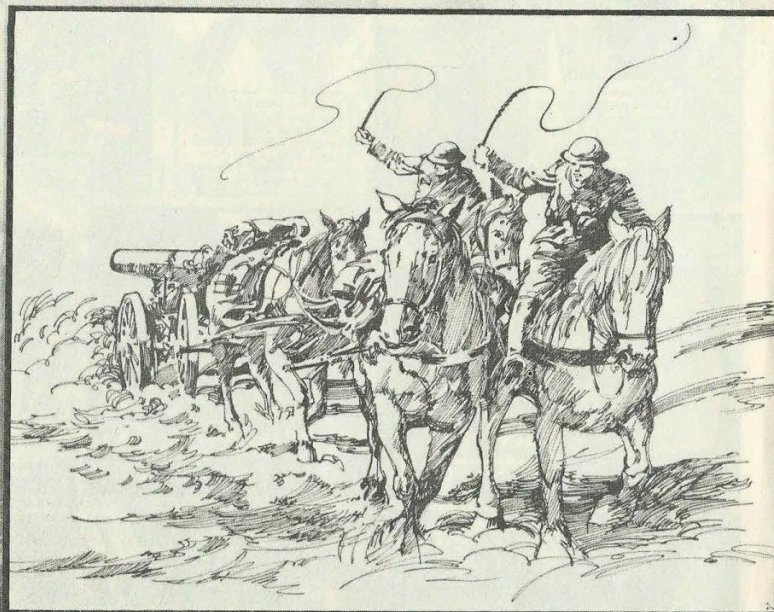
Here is the evidence for — and against — the monster. 1. Humps photographed in 1952 by a holidaymaker. But could they be jagged rocks or the stumps of tree trunks? 2. Farther away and more widely spaced are these humps photographed in 1951. 3. Taken by flashlamp at depth, this picture is said to show the body, with appendages, of the Loch Ness monster. The photographer was from America's Academy of Applied Science. 4. More mysterious humps. These were photographed by Frank Searle (facing page, top) in 1972. Sceptics suggested that it could be a tree or an old animal carcass. But Frank had no doubts. "It's Nessie," he said. 5. What could this be? The caption to this picture, taken in 1934, says, "Photo shows the Loch Ness monster." But the shadowy shape could be anything. 6. No doubt about this one. It definitely shows a monster surfacing in the loch, shaped like a plesiosaur. However, this was a model made for a film and shows that even the most authentic-looking photographic evidence can be deceptive. Tales of the monster in Loch Ness might have remained in the realm of pure fantasy and legend if a road around the lake had not been built and people with their cameras had not spotted strange humps on the still waters.

3





New workhorse of the British army is the FH70 tractor, seen in diagrammatic form above. It will be used for towing the FH70 howitzer into position (left). The tractor can also carry an eight-man gun crew, four ammunition containers and spares for the truck and the gun. This is the latest of the motor-powered successors to the horses which used to haul artillery in earlier times.



THE FOUR-IN-ONE-FIGHTER

One of the best gun-towing vehicles in the western world is now in use by the British army. This is the FH70 tractor, which can also be adapted as an ammunition carrier, a fuel tanker or as a freight conveyor

I N modern warfare, battle fronts can move from place to place very quickly, and because of this there is an ever-present danger of an enemy breaking through. It is, therefore, of vital importance for any defending army to be able to move its men and their weapons rapidly to counter any such threat. Among these vital weapons are the guns of the Royal Artillery. Field guns and howitzers have always been mobile weapons either drawn by

horses as they were in World War I and before, or by mainly four-wheeled motor tractors as in World War II. Guns intended to operate with tanks and other armoured vehicles were often self-propelled. The British Army, part of which serves with the North Atlantic Treaty Organisation's forces in Europe, now has one of the best gun-towing vehicles in the western world — the Foden FH70 Tractor. The FH70, an artillery weapon — the letters stand for Field Howitzer — is

CONTINUED ON NEXT PAGE ►





Trials in Germany of the gun tractor were very promising. The vehicle demonstrated its top speed of 68 mph (109 km/hr) and its ability to climb a 1 in 2 gradient.

a powerful 155 mm gun which can hurl shells 24,000 metres at a rate of six rounds a minute, or one every ten seconds.

The towing vehicle, known as a low-mobility tractor, is a complete and versatile unit in itself. Apart from its driver, and anyone else accompanying him in the cab, it can carry an eight-man gun crew in a heated and ventilated cabin, four ammunition containers, and spares for both the truck and the gun it is towing.

In the centre of the "deck" of the truck is a hydraulic crane which can lift off not only the ammunition containers, but also the gun crew's cabin, leaving the crew in position with their gun while the truck returns to pick up another gun and its crew.

The FH70 artillery tractor

has a beefy 305 bhp Rolls Royce Eagle diesel engine which can power it along at a cracking 68 mph (109 kph) over flat surfaces. But where this unusual vehicle really comes into its own is when it has to cross rough country, as often happens in wartime.

The specially designed axles and springs, plus a nine-speed gear box, enable it to clamber and crawl its way over ditches and hummocks that would leave every other kind of transport except a tank completely bogged down. In low gear, the FH70 tractor can climb a hill with a gradient of one in two — and that is almost like mountaineering!

The rugged chassis of this vehicle can also be adapted as an ammunition limber, a fuel tanker, or as a straight freight carrier. No wonder the British Army already has 1,000 of them on order.



Seen towing an FH70 field piece is the new gun tractor. One of its features is an all-steel cab which can be fitted with either right or left hand drive.

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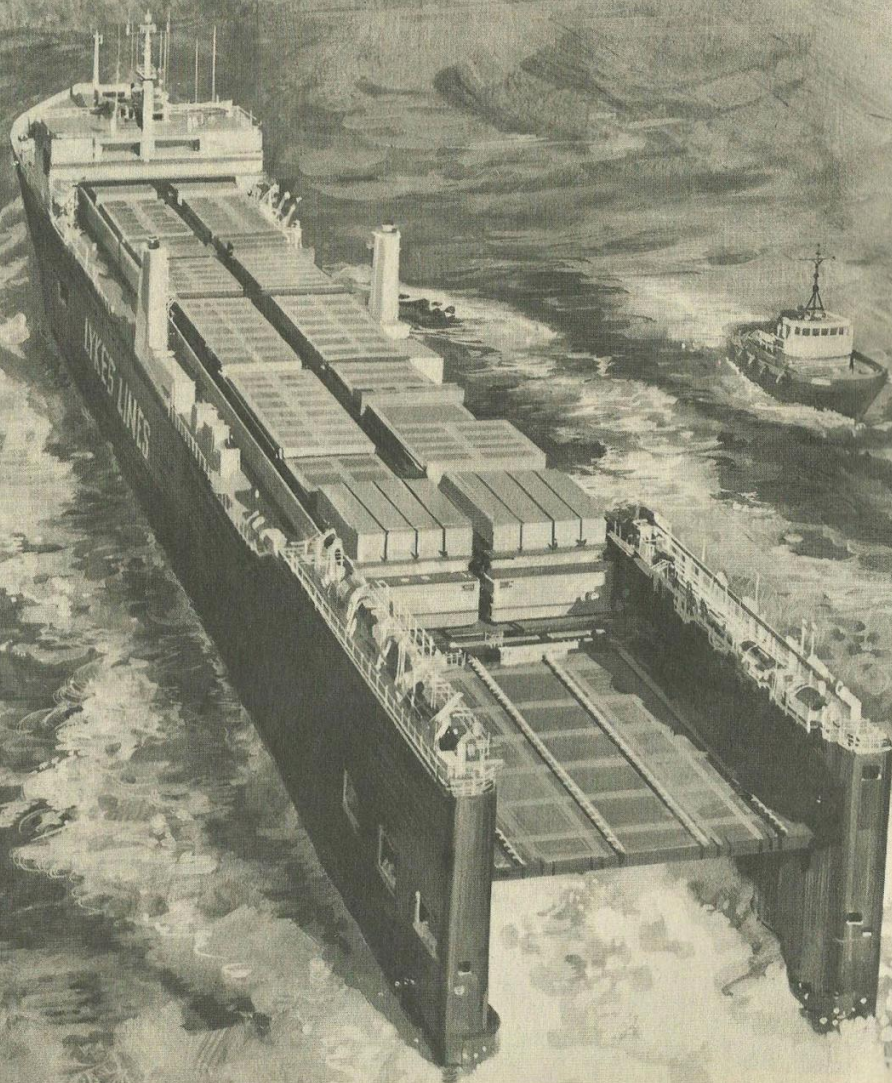
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THE BIRTH OF AERIAL WARFARE

See Inside





THE BUSY 'SEABEES'

DESPITE the tremendous advances made in the size and efficiency of aircraft during the last half century, and their ability to carry both people and cargo rapidly over long distances, it is still one of man's earliest forms of transport — the ship — that remains the most economical means of bulk transport.

Moving things by sea does, of course, take much longer, because, although modern ships can travel faster than the early merchantmen, and have reduced the time taken for some journeys from weeks to days, a great deal of time is still involved in loading and unloading material at docks and harbours.

The ideal situation for a shipping company is to have a vessel capable of handling massive loads of around 2,000 tons unaided, and able to operate independently of any port facilities, so that it does not need to become involved in the time-consuming process of loading and unloading by the usual methods of cranes and barges.

Today, such vessels do exist, and a

Cargo carriers with a difference are the Seabees whose storage holds are as compact as a beehive with their orderly stowage of freight-carrying barges

number of them ply regularly between ports in the Gulf of Mexico and western Europe. They are called Seabees, and are the result of a brainwave by a man named Frank A. Nemec of the American shipping company, Lykes Lines, which has its headquarters in the port of New Orleans, Louisiana, U.S.A.

Frank Nemec realised that most of the cargo for their ships reached them by means of barges which had been towed down the mighty Mississippi and Missouri rivers. On arrival, the contents of the barges had to be labori-

ously transferred to the holds of his ships. Then, after the sea voyage the whole process had to be reversed.

Why not, thought Frank Nemec, have a ship into which whole barges could be loaded and unloaded, thus saving days of expensive waiting around ports? The Seabee ships are the outcome of this bold and imaginative idea.

You may remember reading about them in our 2nd July issue. An article entitled 'The Piggy-Back Barge Carriers' described various types of ships which sailed with barges stowed on their decks and in their holds. One of them, the Seabee, was mentioned briefly then. We thought readers would like to know more about it.

Each Seabee can accommodate 38 specially designed box-shaped steel barges with a carrying capacity of 850 tons. The barges are not just 'containers' but are so constructed that they can be towed through the water like any other river barge.

Where the 'mother' Seabee differs from any other ship ever built is in her

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ELEVATOR ABLE TO LIFT TWO BARGES

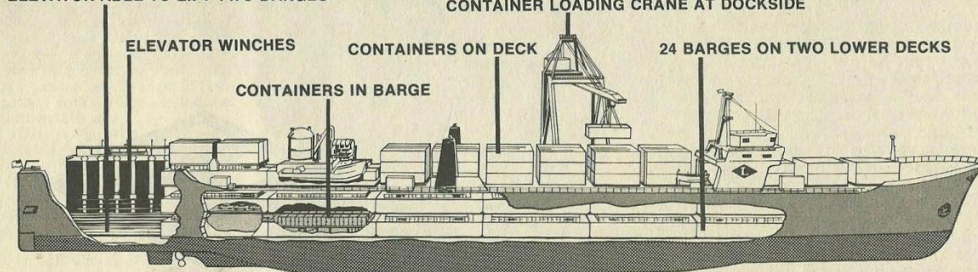
CONTAINER LOADING CRANE AT DOCKSIDE

ELEVATOR WINCHES

CONTAINERS ON DECK

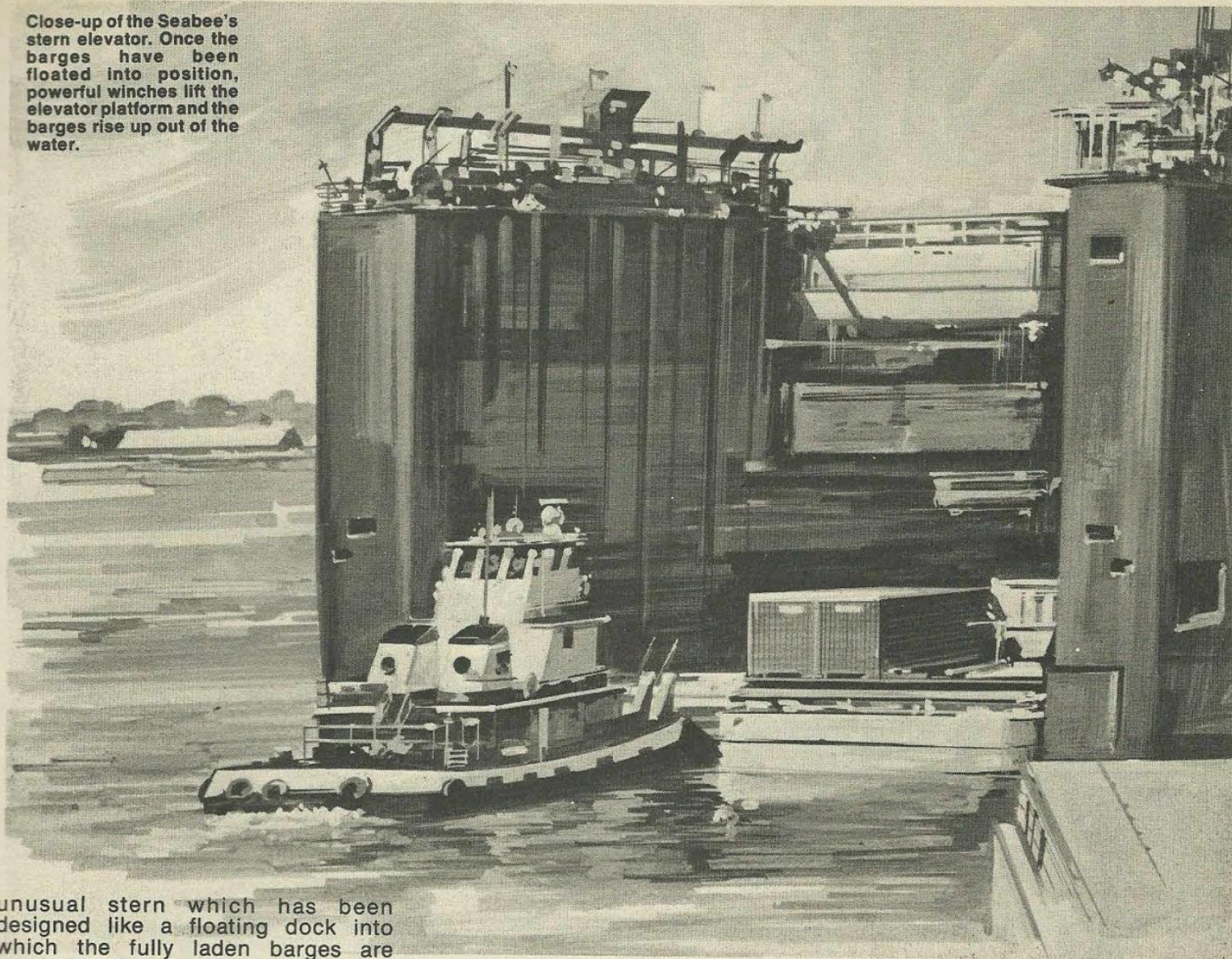
24 BARGES ON TWO LOWER DECKS

CONTAINERS IN BARGE



Cutaway of the Seabee carrier which can be loaded in a little over 12 hours with a cargo of 20,000 tons. Barges are raised by the elevator at the stern and conveyed to their stowage positions.

Close-up of the Seabee's stern elevator. Once the barges have been floated into position, powerful winches lift the elevator platform and the barges rise up out of the water.

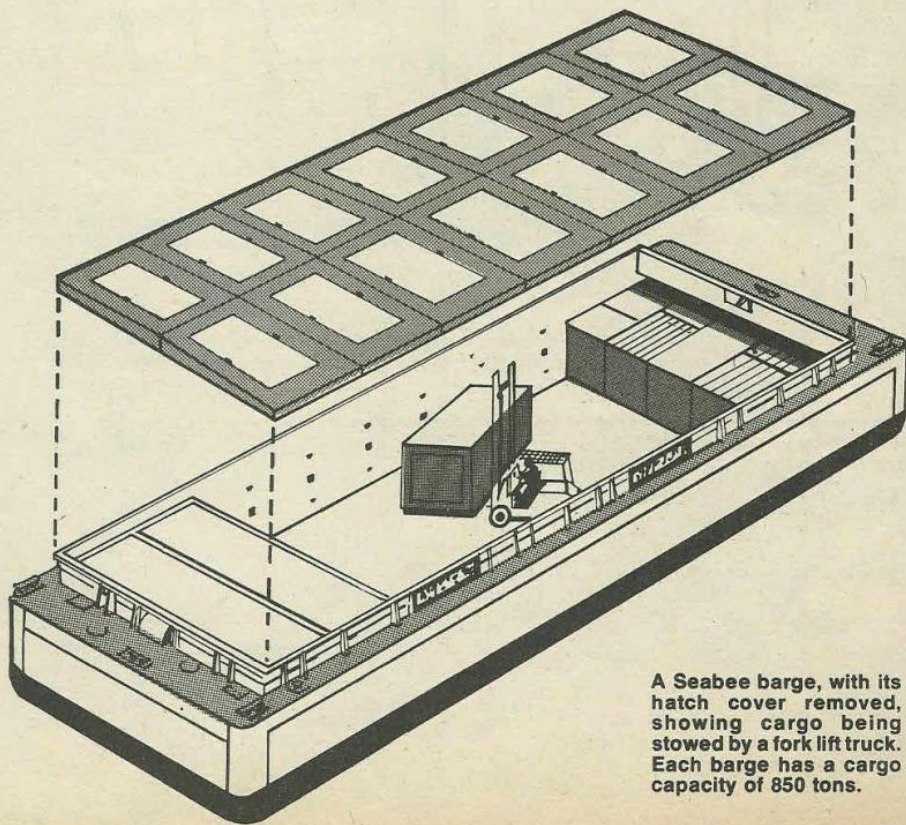


unusual stern which has been designed like a floating dock into which the fully laden barges are nudged by the tugs. The bottom of this stern 'dock' is actually a giant elevator platform suspended from six powerful hydraulic winches, and once the barges have been floated into position the winches lift the platform, and the barges slowly rise out of the water.

The elevator can be stopped level with one of the three vast decks which contain more than three-and-a-half miles (nearly 6 km.) of single-lane highway, and the barges are then ready to be moved into place for making the voyage. The elevator is capable of raising up to 2,000 tons at one go, at a speed of four feet (1.2 m.) a minute. Inside the hull of the Seabee, the cargo officer with his finger-tip control console summons up two huge multi-wheeled transporters which carry the barges to their final positions.

A typical full cargo of around 20,000 tons can be handled in a little over 12 hours by a few skilled seamen on the Seabees.

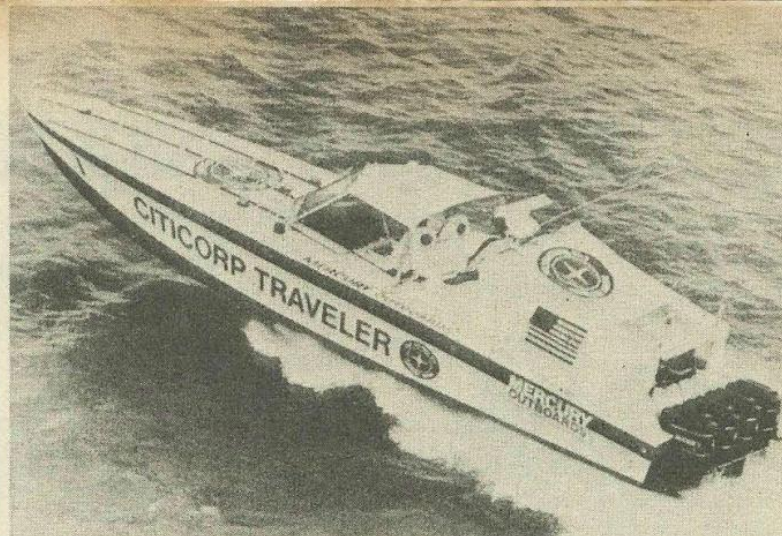
Once at sea, the Seabees' 36,000 hp steam turbines can power it along at speeds up to 20 knots (22.5 mph — or over 35 kmh.) enabling them to make the journey to Europe in about ten days. Then, within 24 hours they can be refuelled and reloaded ready for the return voyage.



A Seabee barge, with its hatch cover removed, showing cargo being stowed by a fork lift truck. Each barge has a cargo capacity of 850 tons.

SCIENCE SURVEY

A look at technical and scientific developments in many corners of the world



SOLAR SATELLITE

LOOKING to the Sun as our next prime source of energy has been engaging the attention of scientists for some time now that we know there is a predictable end to the world's oil and coal reserves. Apart from collecting its heat by means of dish reflectors based on the ground a great deal of work is now being carried out to find effective ways of harnessing its rays in space where, of course, they pour down twenty-four hours a day.

The Boeing Aerospace Company in the United States of America are now examining the use of giant Solar Power Satellites which would be assembled in space by means of the Orbiter Shuttle. These new sun-gathering satellites will be well placed in what are called geosynchronous orbits. This means they keep pace with the Earth as it revolves and appear stationary when viewed from its surface. Because they maintain a constant position 22,000 miles above its surface they will be bathed in sunlight 99 per cent of the time, passing through the Earth's shadow only for very short periods in the Spring and Autumn, when it is late at night on Earth.

The satellites will be huge structures stretching many miles across the heavens, and each will be able to produce twice as much power as that generated by America's Coulee Dam hydroelectric power station, one of the largest in the world. In fact, scientists estimate that 45 of these satellites would be able to supply the total electrical power requirements of the United States, thus freeing oil, coal and their by-products for other important needs.

Two different methods of generating power can be used in the satellites; they can be either photo-voltaic or employ what is called a Brayton heat engine.

A photo-voltaic satellite would be rectangular in shape, and any space traveller approaching it

would be astonished by its size, because it would cover an area of almost 50 square miles (128 sq. kilometres) — the size of a small city. On this vast platform would be mounted about 14 billion solar cells, whose function would be to transform sunlight directly into electrical energy in a way already used to power small orbiting satellites.

The Brayton heat engine satellite would use a series of four giant parabolic dishes, each about 3.5 miles across. The dishes themselves would be made up of thousands of extremely thin, steerable plastic reflectors (see illustration). These reflectors would direct the Sun's rays into dome-shaped solar furnaces located over each dish. The concentrated sunlight would superheat gases, which would expand and drive a series of turbo-generators fitted round the furnaces.

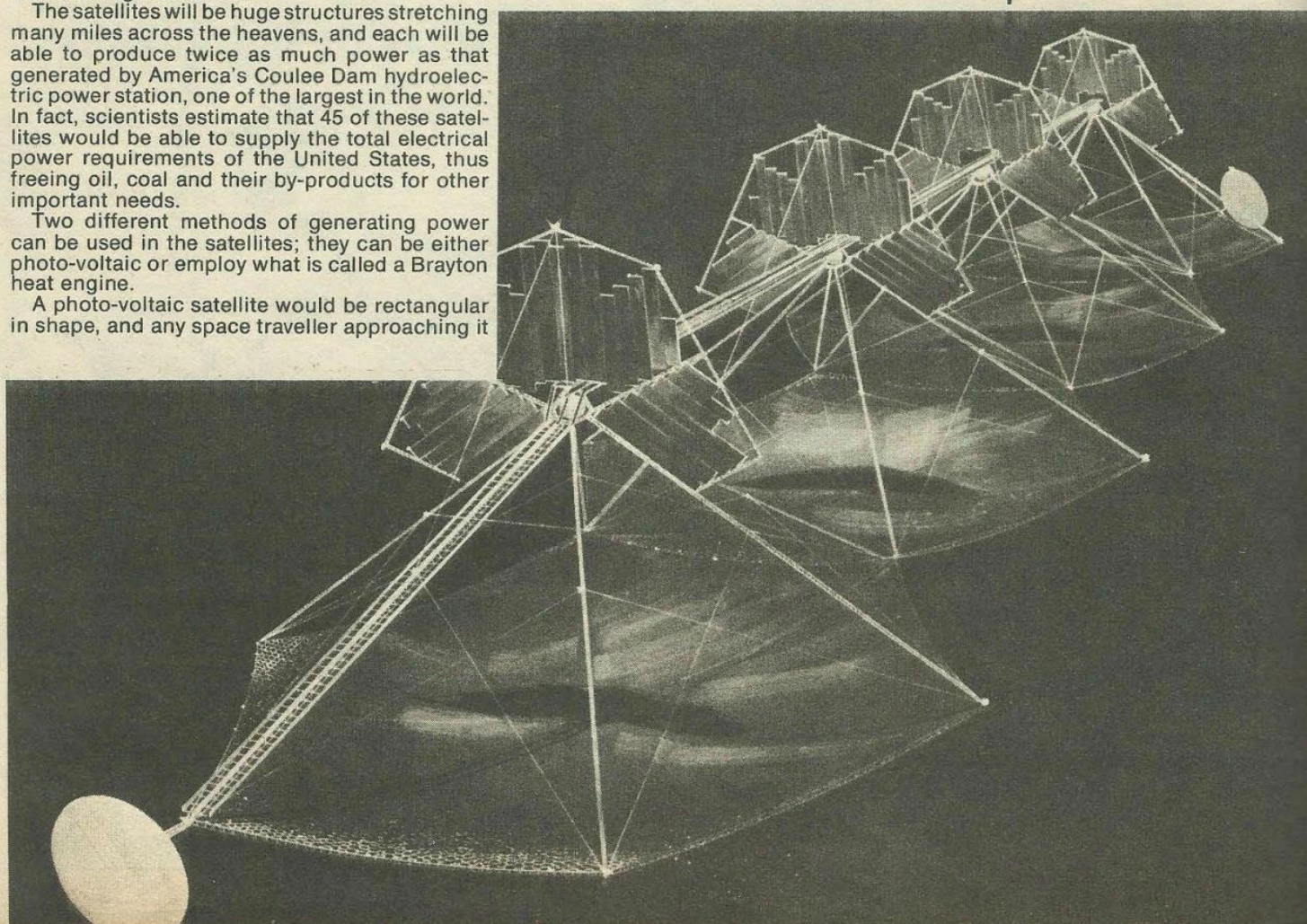
Once through the generators, the heated gases would be piped into large, fin-like radiator panels where they would cool before being recirculated and used again. Both the photo-voltaic and the Brayton heat engine would weigh between 88,000 and 110,000 tons.

ATLANTIC RACER

Off shore powerboat racing champion Dr. Bob Magoon is seen here testing his Citicorp Traveler in Miami's Biscayne Bay, U.S.A. in preparation for an attempt to cross the Atlantic in early July.

Magoon and his three mates will be hoping to better the record average speed of 40.9 mph — or 65.95 km/hr — set by the liner, S.S. United States during a 1952 crossing.

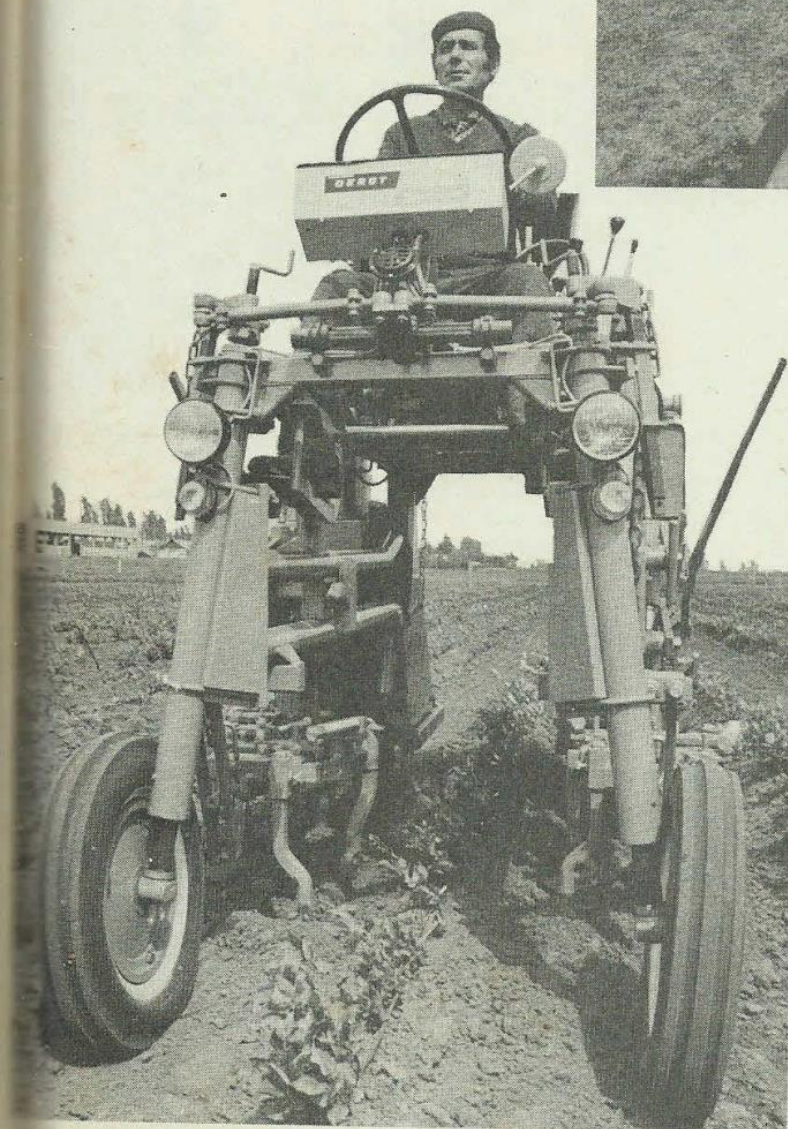
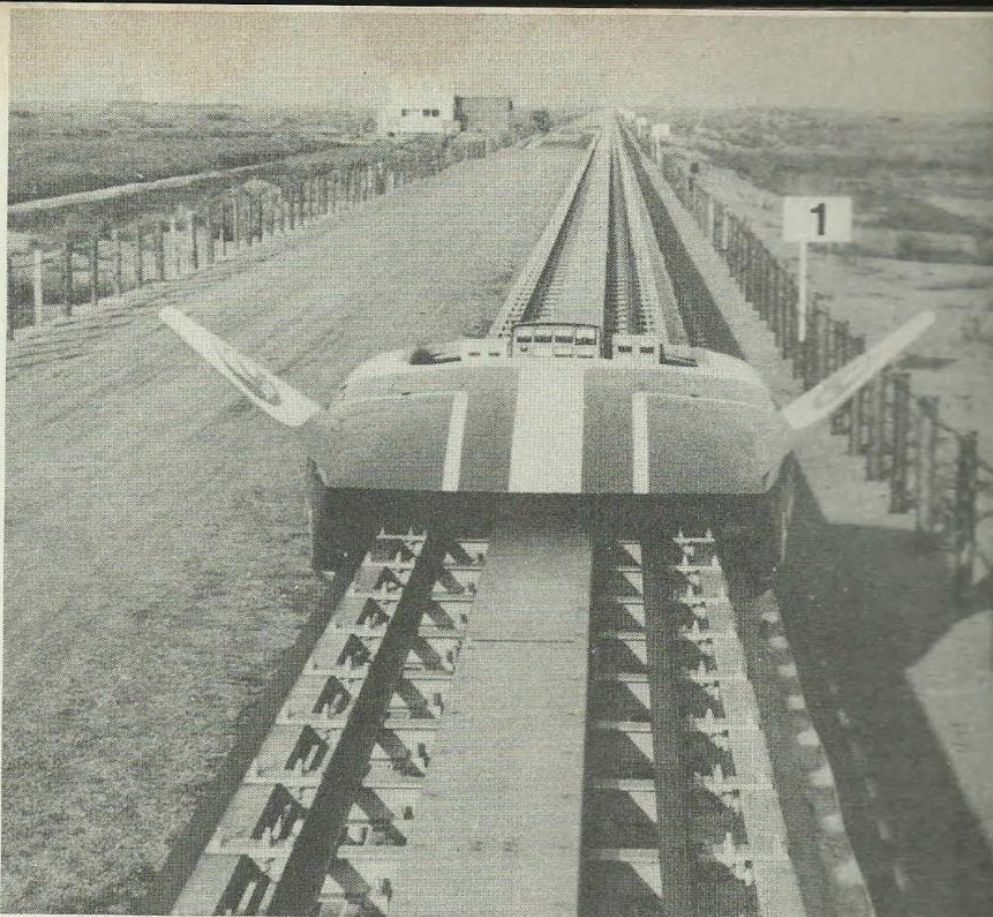
They plan to travel from Rota in Spain to Newport, Rhode Island, a distance of 3,465 miles — about 5,000 km — in their record-breaking attempt.



FLYING TRAINS

Almost 106 million people live on the Japanese islands making the country one of the most densely populated in the world. Like Britain, which is also densely populated, (although less so than Japan) the Japanese have to have an efficient transport system, and some of their express trains are amongst the fastest in the world.

But railways take up valuable land space, and now Japan Air Lines are experimenting with an elevated railway which would be able to carry passengers from towns to outlying airports at speeds of up to 190 mph. A length of track near Tokyo has been in use for some time so that high speed tests of the system could be carried out with an experimental vehicle (see right).



HIGH RIDER

High above the rows of growing plants rides this driver on his long-legged tractor. His machine is hoeing between orderly lines of young trees which will later be transplanted to forestry land for the production of timber. But before they are moved they will have grown considerably taller, hence the height of the tractor.

Made in France, the tractor is seen here being used at a farm in Hungary where work on 120 hectares — about 300 acres — has been entirely mechanised.

Last year, 900,000 trees were grown at the farm with the help of machinery like that in our picture.

LOOK — NO DRIVER!

Passengers boarding their bus in Germany sometime in the future could have a shock. While they are waiting for the driver to arrive, they could see, with startled eyes, their bus starting off all by itself with an empty driver's seat.

This is a possibility which has been investigated by the German firm of Daimler-Benz, which makes buses, lorries and cars.

The driverless buses they envisage could be guided by sideways-facing wheels running along the sidewalls of special tracks. Sensors would transmit, to the steering, any change in direction.

The buses could run in special lanes and in tunnels.



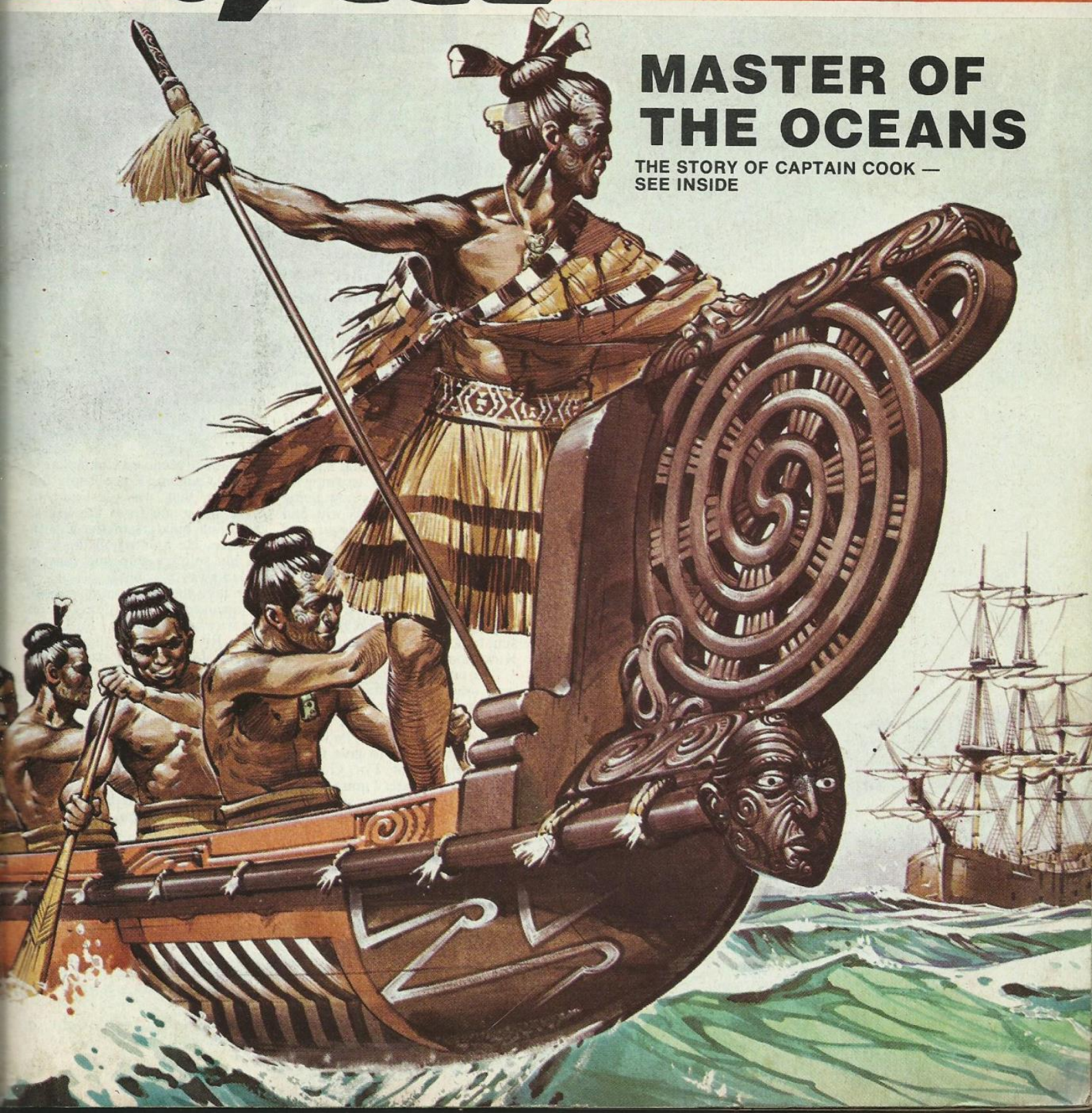
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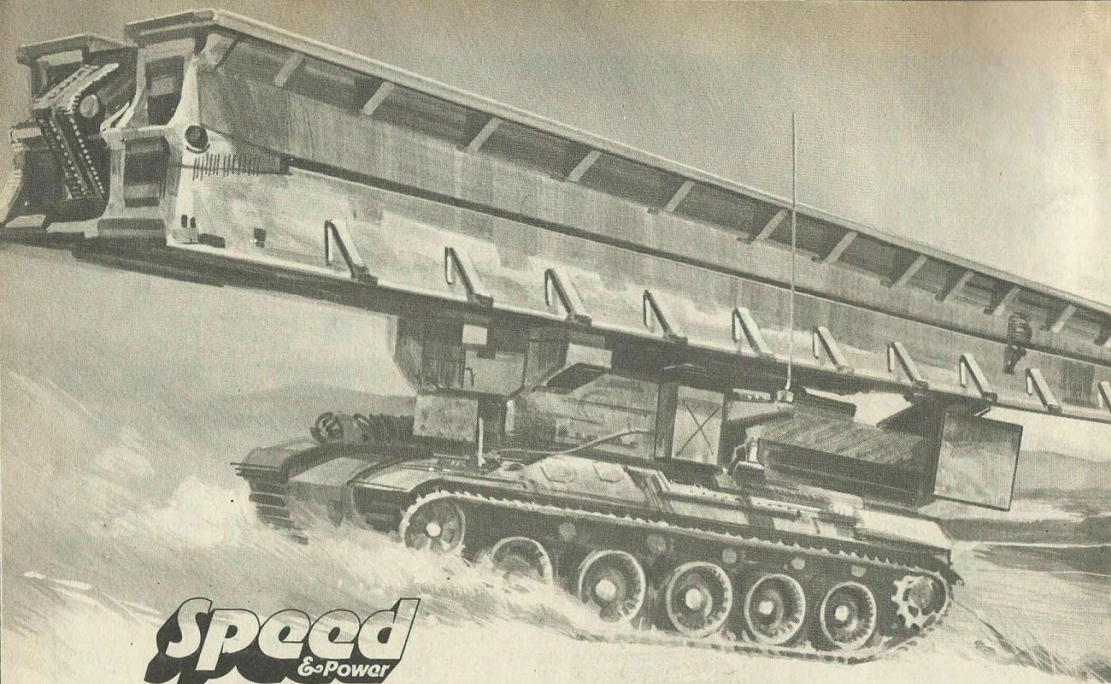
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THE STORY OF CAPTAIN COOK —
SEE INSIDE





**Speed
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THE TEN~MINUTE BRIDGE BUILDER

Rivers do not halt advancing armies equipped with the latest high-speed bridge constructing machines

TEN minutes to lay a bridge across a river. It sounds like the work of a superman. Far from it. The high-speed bridge builder is a French AMX-30 army tank which carries on its back a ready-made bridge constructed of a light but extremely strong alloy.

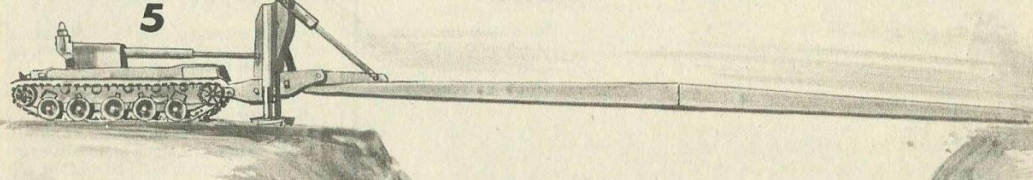
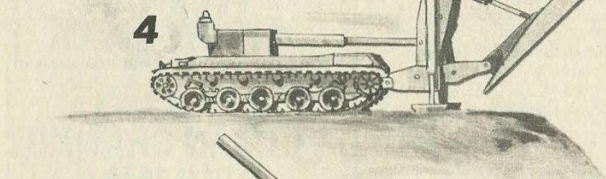
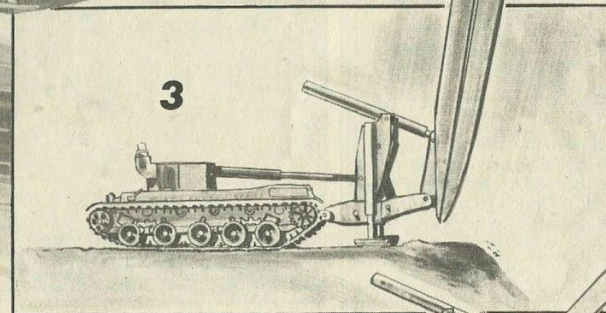
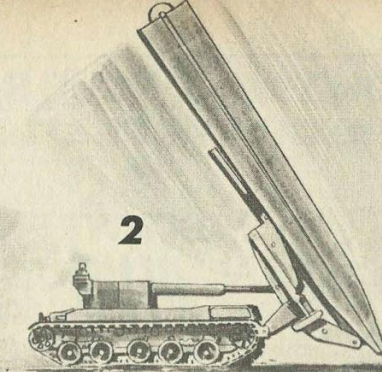
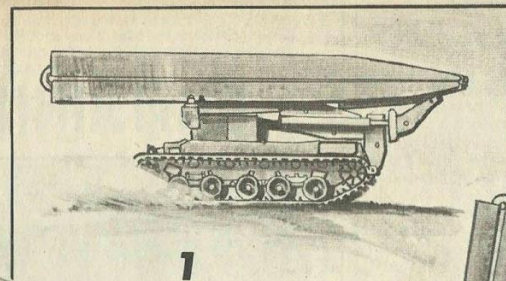
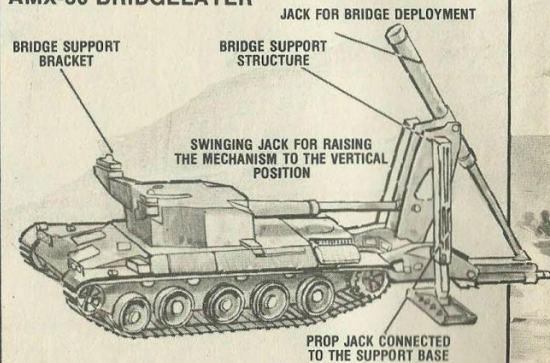
It uses a Titan-Coder class 50 bridge which it unfolds, like a pair of scissors opening, and extends across a river of up to 21 metres or 69 feet wide. Our sequence of pictures shows you how this is done.

1. The bridge builder under way.
2. The folded bridge is raised.
3. A support for one end of the bridge falls into position.
4. The scissors open out.
5. The completed bridge.
6. Onward rolls the army to meet its foe.

Operated by its crew of commander, driver and bridge operator, the AMX-30 can carry its bridge at a speed of 55 km/hr or 34 miles an hour, or travel without the bridge at 60 km/hr or 37 mph.

Normally, the bridge would be carried by lorry until it was transferred to the tank for its journey into the forward battle areas. Once there, the bridge's erection is hydraulically controlled from inside the tank, thus minimising the danger with which the crew would be faced should they have to leave the tank.

AMX-30 BRIDGELAYER



Bridging a river is a swift and efficient job for the AMX-30 army tank and its Titan-Coder class 50 portable bridge shown here. It uses the "scissors" system, as illustrated, and can span rivers and ditches with equal ease. Once laid, the bridge provides a single track wide enough for army vehicles.

BRING BACK THE TRAMS

This could be the cry of politicians if a strong public demand grows for pollution-free public transport that uses fuel economically and efficiently. But they will be trams with a modern look

If you heard a politician say, "Let's bring back the tram-car," you might wonder if Britain was taking a step backwards to the days of the old clanging, clanking vehicles that used to travel on lines sunk into the middle of many of the roads in our towns and cities. But today, the word "Tram" means something quite different.

Because the world's oil supplies will eventually become exhausted, some forms of public transport that do not use diesel oil or petrol will have to be found before the end of this century. Britain may therefore one day have its trams back. But they will be very different from the old trams.

The new trams visualised by transport engineers have been designed as part of a fully automated system that will use small, driverless vehicles controlled by computers; and in congested cities they will run along overhead tracks to keep them clear of pedestrians.

These Minitrans would each be able to carry a normal load of six people seated, with another six standing, but they could carry twice that number for the short rush-hour periods.

Running along a narrow-gauge rail slightly over one metre in width, the Minitrans could be used singly or coupled

together to form short trains. Low sidewalls on each side of the track would carry electrical power in conductor rails, and specially shaped "shoes" on the Minitrans would pick up the power to drive the traction motor which operates all four wheels.

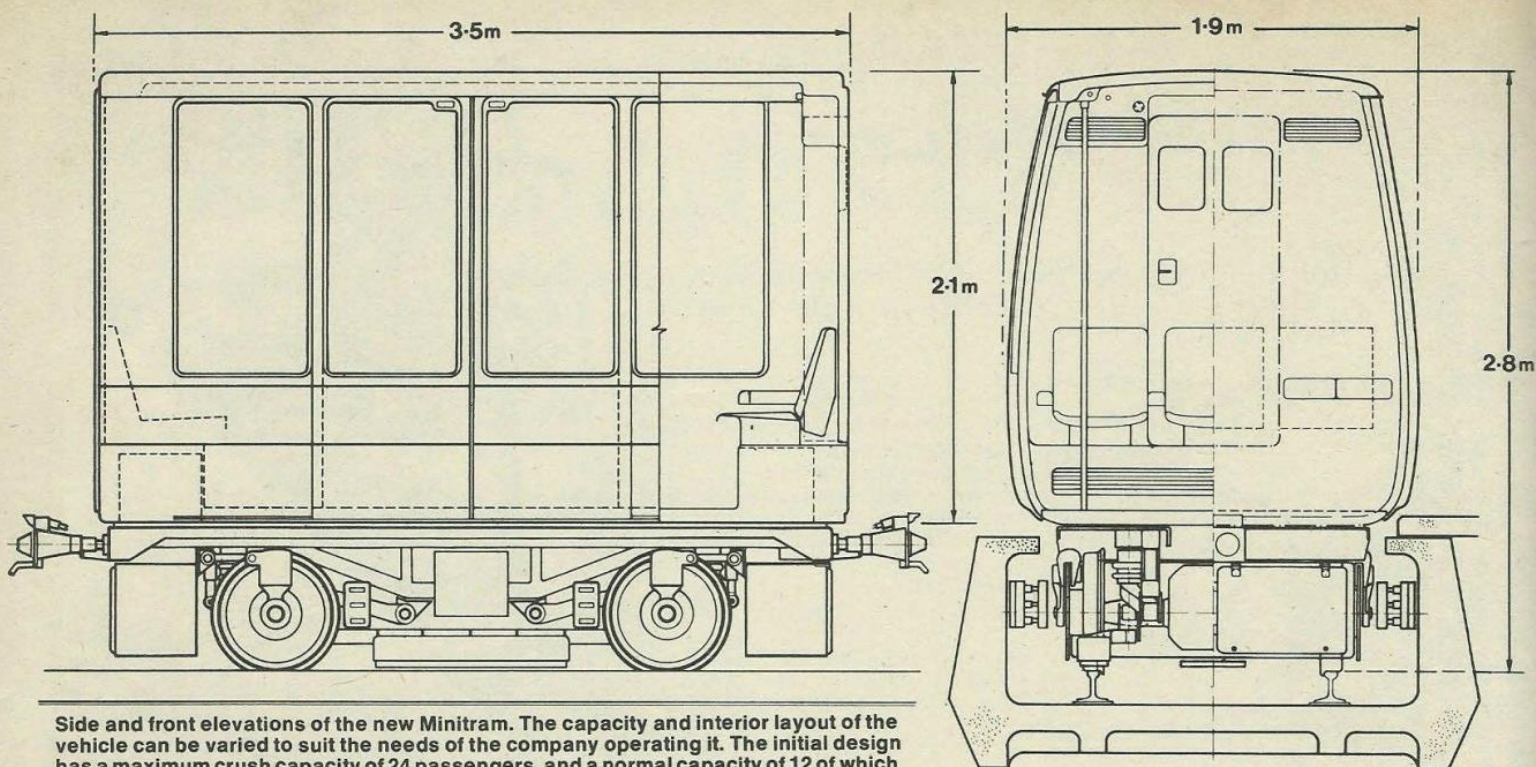
Being light and well-powered, the Minitrans will accelerate rapidly and their motors will be powerful enough to take them up gradients as steep as one in ten. In severe winter conditions, the track will be heated by means of a powerful electric current so that ice and snow do not put the system out of action.

CONTINUED ON NEXT PAGE ►

Speed
& Power

Riding high on their elevated tracks above roadless shopping precincts, the trams of tomorrow — driverless and computer-controlled — could be the answer to today's traffic jams.





Side and front elevations of the new Minitram. The capacity and interior layout of the vehicle can be varied to suit the needs of the company operating it. The initial design has a maximum crush capacity of 24 passengers, and a normal capacity of 12 of which 6 are seated and 6 standing. The vehicle's pneumatic springs allow the floor height to be adjusted as the load increases so that it is always level with the station platform.

Although Minitrams can have their trackways laid at ground level, there is no question of would-be travellers having to dodge their way through traffic to board the coaches. The trackways would be close to the pavements, probably running along where today's bus lanes operate.

They could also be run underground, although tunnelling would be expensive, and it is likely that the transport authorities of most towns would use an elevated system supported on slim pillars. This method would also allow the stations to be built above ground, giving clear access to shopping areas and saving valuable space.

The stations will have low platforms, and will probably be placed not much more than 350 metres apart. It will seem very strange to the first travellers as they wait for a driverless Minitram to move silently into a station, and then open its doors.

The average stopping time will be about 15 seconds, but everyone will be able to get aboard because the doors will be of the sliding type that can easily be held apart, and the tram will not start while any of them are open. Once everyone is aboard, the doors will close, and the Minitram will move off quietly along its route, stopping at whatever stations have been programmed into its controlling computer. Speeds will be about 35 mph (56 km/hr), and the computer will automatically maintain a 12 second gap between trains.

Stations will usually have a short length of loop line which will allow the unimpeded passage of trams not programmed to stop, while passengers are boarding others.

The computers at central control will always know where every Minitram is at any given moment by means of signals received through "loops" of wire built into the track

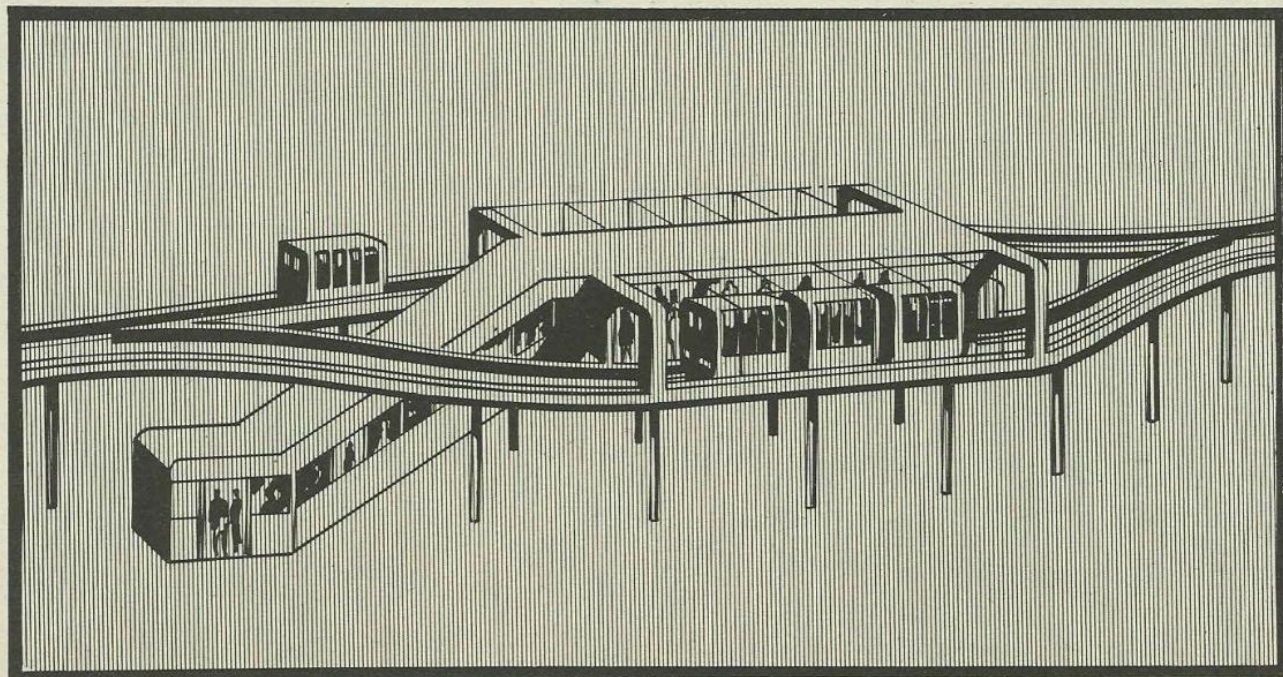
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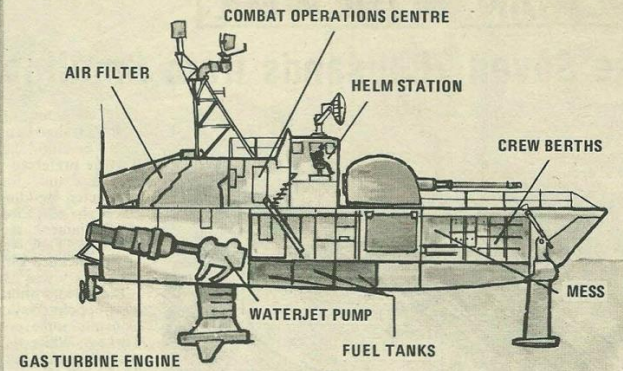
The system will also have "fail-safe" devices built into it. To reassure passengers in case of a breakdown, there will be a telephone, enabling them to speak to a human controller at the computer centre.

Minitram systems are already in use at Dallas International Airport in Texas, USA, and short, experimental lengths of track are operating on the continent of Europe. In Britain a company called GEC-Elliott Automation Limited has already submitted detailed plans for Minitrams to the Government for study by the Transport and Road Research Laboratory, a part of the Department of the Environment.

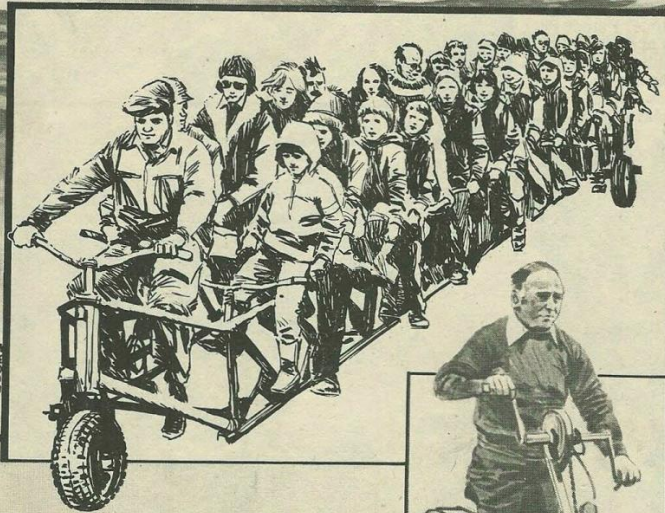
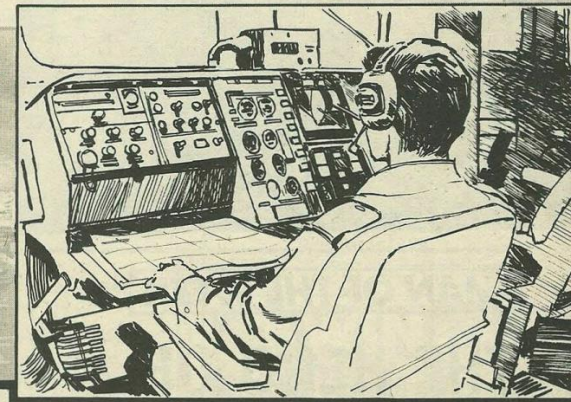
Some local authorities have already expressed an interest in the new trams, but the economy of the country may have to improve before this transport revolution finally reaches our streets.

Stations will usually incorporate a short length of loop line allowing the unimpeded passage of trams which are not stopping while passengers board stationary trams. An alternative arrangement allows trams to stop at either side, and at off-peak hours the loop track can be used to park vehicles until they are called into service.





Right: the dazzling array of instruments gives a decidedly aeronautical flavour to the Sparviero's bridge. The eight-man crew includes two officers.



STRANGE BIKES

The construction above was put together in Denmark by a Jutland mechanic using 78 old bikes and over 160 feet of chain. This 20-foot monster is pedalled along by 35 people! Meanwhile in Italy, an inventor has come up with a bike (right) with revolving handlebars which drive the front wheel, aiding tired legs.



SCIENCE SURVEY

A look at technical and scientific developments in various parts of the world

MISSILE hydrofoils represent a very new area of naval development, and Italy has really made her mark in this department with the P-420 Sparviero — the Swordfish. Built for a coastal defence role so vital in the Mediterranean arena, the Sparviero can skim the seas at high speeds to deliver its deadly cargo of Otomat Mk. 2 missiles. To save space, the crew live on shore, alongside a special trailer which houses spares and machines to repair the craft. The Sparviero also carries armament to protect it from attack, but its true safety lies in its speed and manoeuvrability — it can make fast turns five times as tight as conventional vessels can at slower speeds. Powered by a 4,500 h.p. Rolls-Royce gas turbine, the hydrofoil can operate for 400 miles (640 km) at a continuous speed of 45 knots before refuelling.

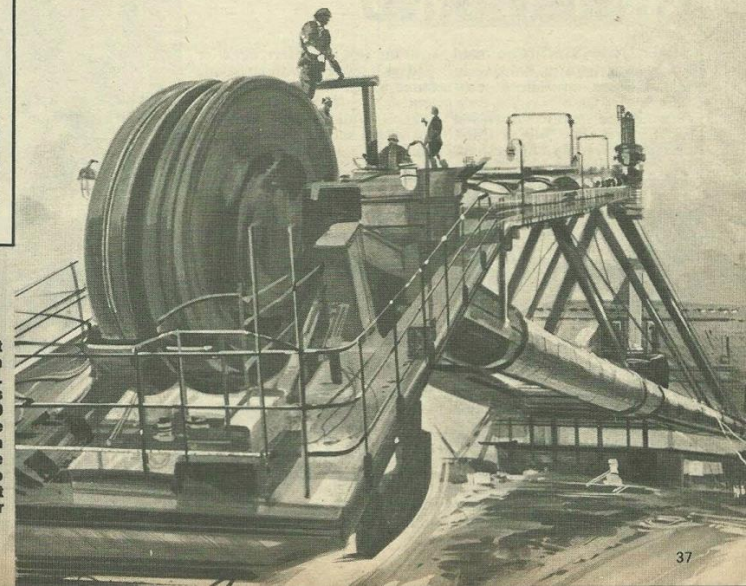


... BOUNCING BACK

Higher oil prices are helping natural rubber bounce back in the face of competition from its synthetic brother. From a predicted low of 25%, it now accounts for a third of the world rubber market, and the share is climbing. One consequence is that the rubber reclaiming industry is coming into its own after years on the sidelines.

WALKING HEAVY

This Soviet walking excavator is in use at an opencast mine near Krasnoyarsk in Western Siberia. Its bucket holds 100 cu. m. and its dragline can scoop up 160 tons of rock and shift it some 200 metres (220 yards). It has four "shoes", which are lifted hydraulically 10 cm. (4 inches) from the ground, when it makes its three-metre (10-foot) steps. The dragline can take up to 20 such steps an hour. Now Soviet engineers are planning an even bigger one.



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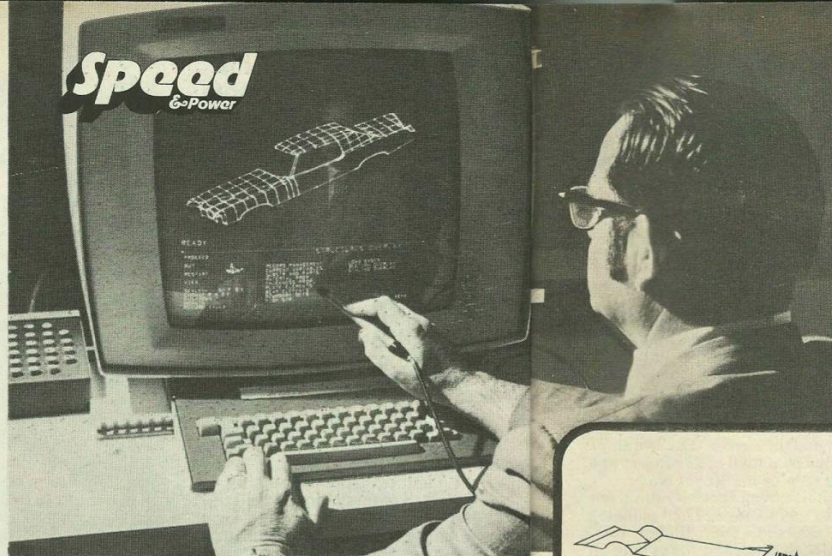
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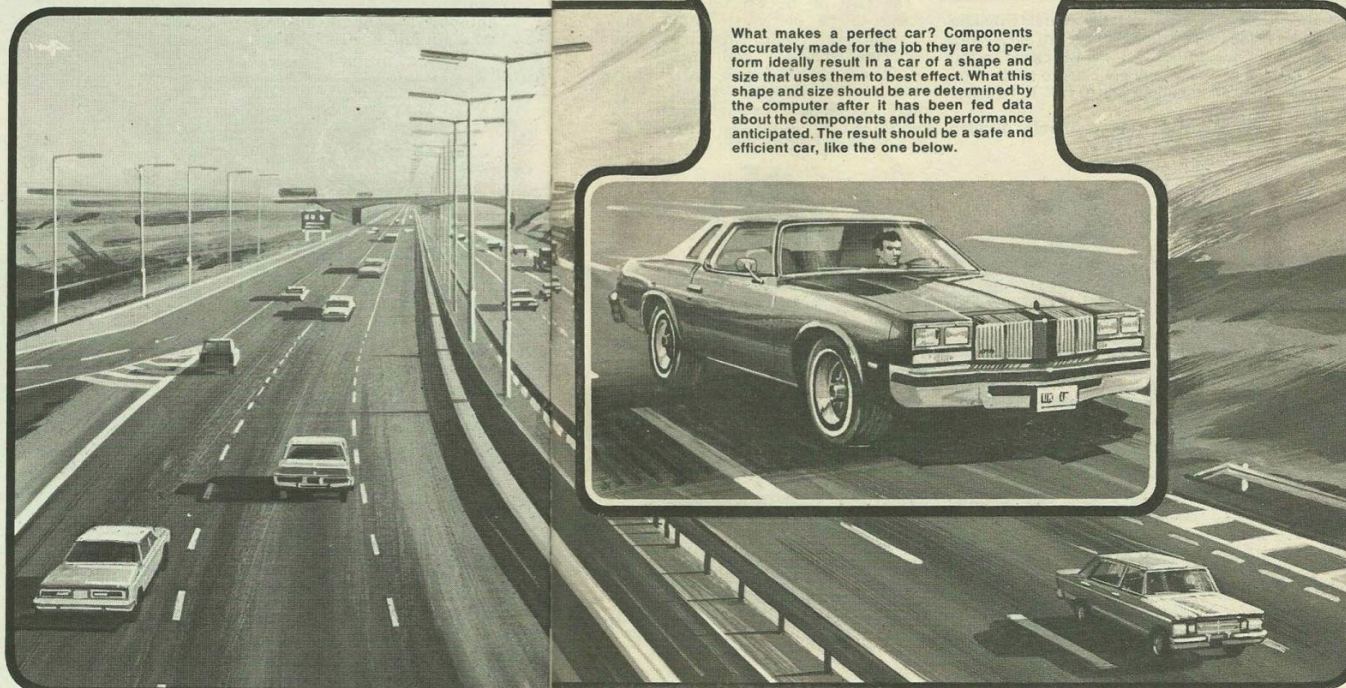
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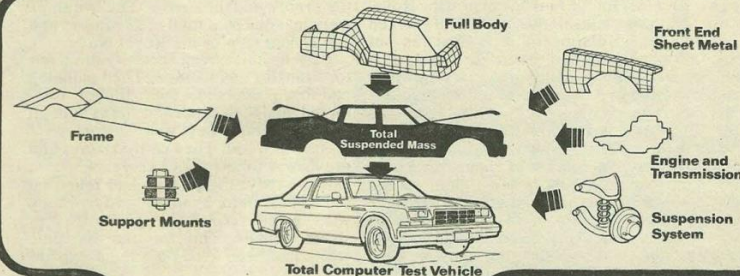


Comfort, safety and reliability... what sort of car must be built to incorporate a designer's requirements in respect of these three essentials. The computer will tell him and show him a picture of a design that will suit his needs. If he wants to make any changes, the computer will show him the result of these — in a flash.



COMPUTER CARS

Computers are providing car designers with a short cut to efficiency in America, where they are ironing out many of the snags involved in getting a new car on to the road



What makes a perfect car? Components accurately made for the job they are to perform ideally result in a car of a shape and size that uses them to best effect. What this shape and size should be are determined by the computer after it has been fed data about the components and the performance anticipated. The result should be a safe and efficient car, like the one below.



BECAUSE of the immense amount of work involved, it can take up to four years to design a motor car and get the resultant vehicle on to the road. Hundreds of drawings have to be made, early-design models have to be built and prototypes tested. All this has to be done before the new model, at a cost of millions of pounds, can be put into mass production.

A great deal of time and money is used up in this design, build and test sequence. However, one of America's big car manufacturers, General Motors, are using a computer to reduce this period by many months.

The computer is fed with mathematical information about the car the designers are proposing to build. After analysing this, the computer produces data which shows whether the design is a good one or not and if any changes should be made.

Upon the report they receive from the computers, the designers can decide whether it is worthwhile for them to build a prototype of the car they have in mind.

All of the car's complicated parts are examined by the computer, which indicates the best weight, shape and materials for these. Sections such as the body, sub-frame, engine, suspension system and brakes are all examined in this way.

A system known as computer graphics enables an engineer to sit at a TV-type screen and see pictures of parts of the proposed car, "drawn" for him by the computer. He can then alter its shape and see what results this has for other parts of his design.

The first car to have its design changed by a computer was a 1976 Cadillac. Following the success of this, other cars, vans and lorries were designed with the computer's aid and, undoubtedly, there will be many more to follow.

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***Will The Next War
Be Fought In Space?***

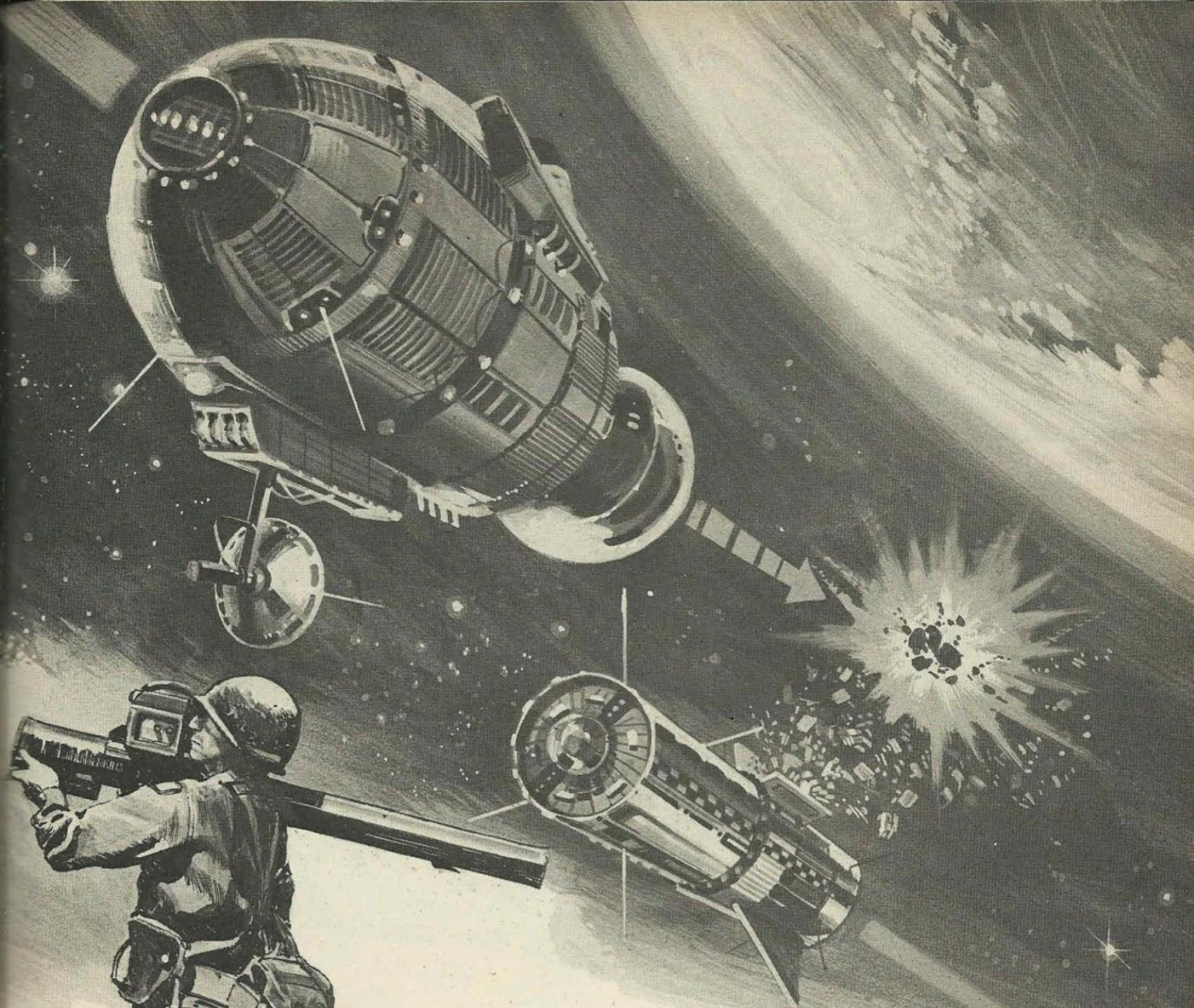
See Inside

Speed
& Power

Three forms of space warfare. Above: a spy satellite is put out of action by a laser beam from Earth. Middle: a space shuttle captures an enemy. Right: one satellite rams another and blows them both up.

WAR GAMES IN SPACE

According to the predictions of some scientists, a war could be fought in outer space of which we on Earth would have little knowledge



The nearest approach to a death ray is the weapon on the left. A laser beam is aimed at the target and a rocket travels along the beam. Above: a mine-laying satellite puts explosives in the path of an enemy satellite. The mine layer is in the lower part of the picture.

TWO Russian satellites were manoeuvring in space. They were playing a kind of war game in which one was the hunter and the other its prey.

The hunter circled the victim as if examining it. Then it used a camera to "shoot" its victim.

At least, that is the interpretation western observers put on this "game" in space. And they were aghast at the implications, which suggested that if you can manoeuvre two space craft close enough to each other so that one can photograph its companion, you can also order one to

fire a destructive charge at the other.

The possibility gives rise to a vision of a far more frightening form of warfare taking place far above our heads in outer space... one in which an early warning satellite, "killed" by a laser beam would fail to detect an invading force... in which a space shuttle could use mechanical claws to grab an enemy satellite and pull it into its vast cargo bay... in which one satellite could turn another into a molten mass of wreckage.

Crazy, illogical, far-fetched? Perhaps it seems so, but it could all happen in

the future, according to space experts who have been studying the possibilities of extra-terrestrial warfare.

To shoot down a satellite seems a waste of effort. Why should anyone want to do that? The reason, simply, is that satellites are a nation's first line of defence — they are its skyborne eyes which give warning of an impending attack. To destroy them leaves a defending nation at the mercy of its attackers. An aggressive nation could cripple its opponents' forces in a very short time without

CONTINUED ON NEXT PAGE ►



A continuous wave gas laser is being operated by the man in the foreground. The action in the background shows a hunter-killer satellite detecting a missile and knocking it out with a laser.

having to sink a ship or knock a plane out of the sky.

Years ago, the Russians realised this and began developing a satellite able to smash intruding foreign satellites to smithereens.

It is no secret that satellites carry explosive charges that can be detonated upon a radio command from Earth. The object of this is to make it possible to destroy satellites that have moved out of their orbit, whose instruments have ceased to function or are otherwise no longer useful.

Recently, two American satellites encountered a strange phenomenon while passing over Soviet territory. One was an early-warning surveillance satellite designed to detect any warlike activity. The other was its message-relay satellite.

Somehow, the surveillance satellite's "eyes" were put out of action, and its accompanying satellite made completely useless.

The American explanation is that the highly sensitive "eyes" on their satellite were blinded by the brilliance of the glare of flares from a natural gas pipeline. But the sceptics doubt whether the flares would have been bright enough to have this effect. They are wondering whether a high-powered experimental laser beam from Earth could have done the damage.

To protect their satellites, the Americans have fitted them with alarm systems which send a warning to Earth if they are attacked by another satellite.

On TV screens on Earth, watchers will be able to see the attackers because the

satellites will have very efficient TV cameras and high-powered lights. They will also have the rocket power and extra fuel to escape from their attacker.

Backing these up would be suicide satellites that would get rid of an enemy by flying close to it and exploding.

Other ideas being considered in America include the use of satellites which release explosives in the path of an enemy and the employment of space shuttles with big cargo bays. They would snatch the satellite out of space and scoop it into its bay.

Although space warfare is in the future — because treaties by Russia and America ban weapons from space and leave spy satellites unmolested — in ten or fifteen years' time, the pic-

ture could be different.

What could change it might be a weapon that could destroy its target with one shot and have no effect upon the vehicle from which it was fired. In other words — a death ray. The closest to this at the moment is the laser beam which, in space, could knock out a satellite or an intercontinental ballistic missile.

Another "death ray" idea is the particle-beam weapon which sends out streams of protons and electrons. The Russians are reported to be expecting to have one of these operational by the 1980s.

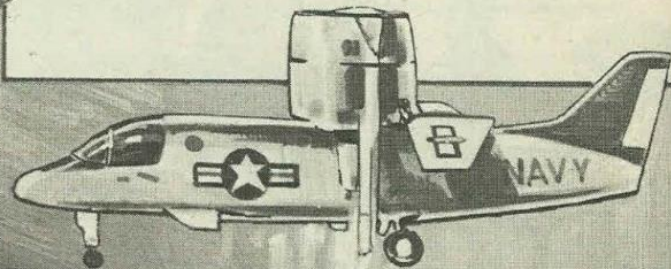
However, a war in space is something nobody could win. There could be only losers and no victors. Perhaps this is why it may never happen.

SCIENCE SURVEY

Another look at some of men's achievements and discoveries in this modern world

NEW US JUMP-JET?

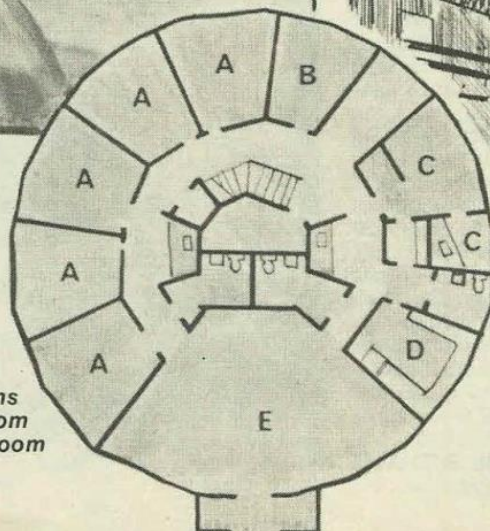
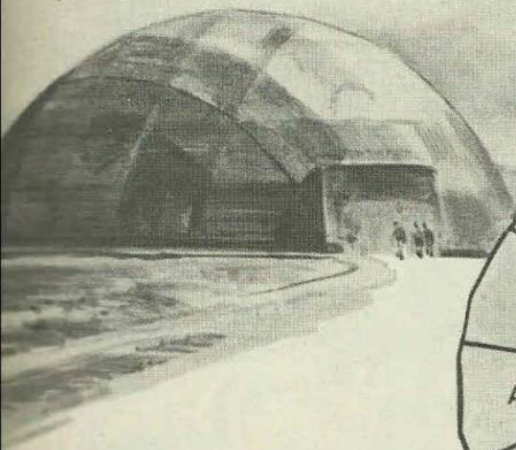
ONE of the most recent products of the American drive to manufacture jump-jets for operation from smaller ships is this proposed aircraft from the Grumman company, known at present simply as No. 698. It is powered by two swivelling turbofans mounted on the wing, connected by a shaft to provide continuous power should one engine fail. If ordered by the US Navy, it will be used for warning, anti-submarine and rescue work.



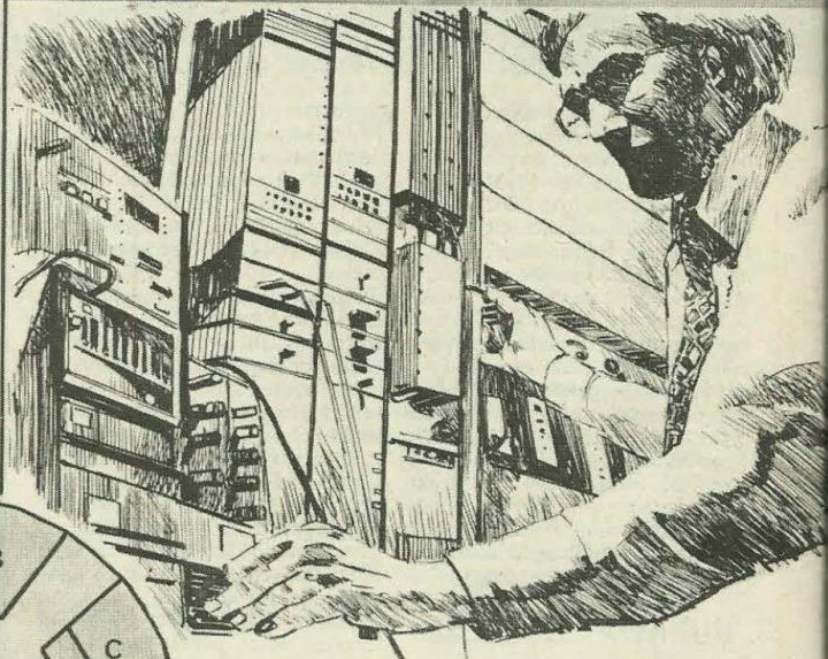
INSTANT CLINICS

New "Medidomes" like the one pictured below may shortly be springing up all over the USA. The first dome was built in just four days, and serves migrant farm workers in Florida, under a programme financed by the American Department of Health, Education and Welfare. It can handle up to 250 patients a day.

The dome has a diameter of 60-foot (about 18 metres). The frames, made from extruded aluminium and built to withstand winds of up to 100 mph (about 160 kmh), are clad with laminated panels.

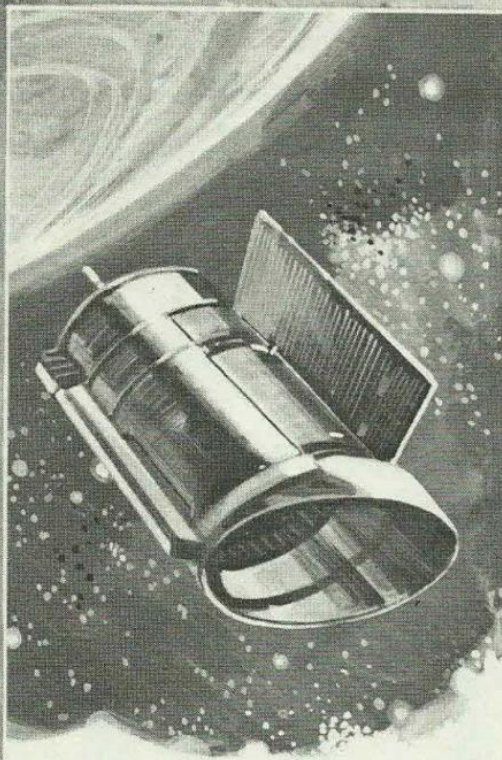
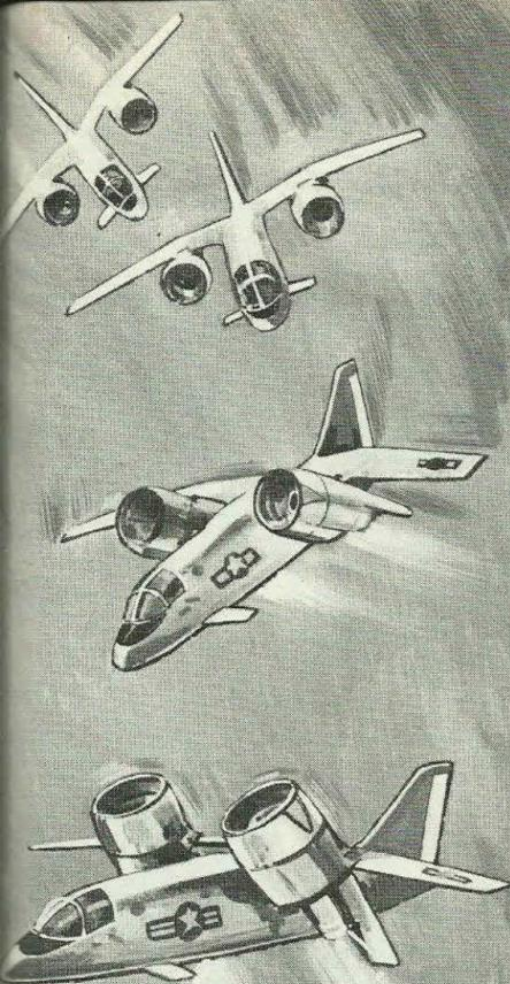


- A. Examination Rooms
- B. Minor Surgery Room
- C. X-Ray and Dark Room
- D. Laboratory
- E. Waiting Area



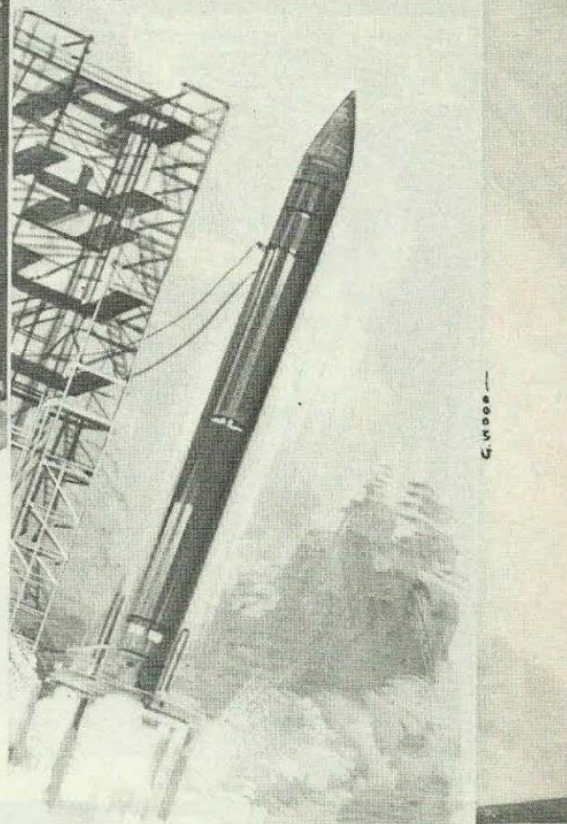
TRIAL OF STRENGTH

The British company, STC, is subjecting a new optical fibre communications system to rigorous tests to prove its strength and practicability. A six-mile route has been installed, and the trials are to ensure that the line can live up to its claimed capacity to handle 2,000 telephone calls simultaneously.



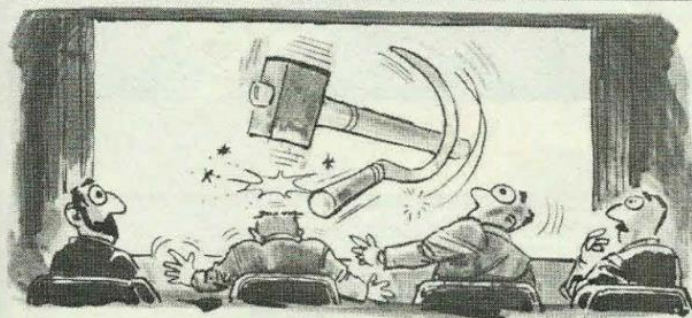
ROCKETS ON THE CHEAP

A West German company is shortly to go into commercial production of space rockets. Using 'everyday' materials, the rockets will cost much less than those used by NASA. Picture below shows a prototype satellite launcher.



INFRA-RED ODYSSEY

In four years time, this satellite will be launched into orbit, the first specifically designed to chart the infra-red sources in space. A computer on board will process about 500 million pieces of information every day.

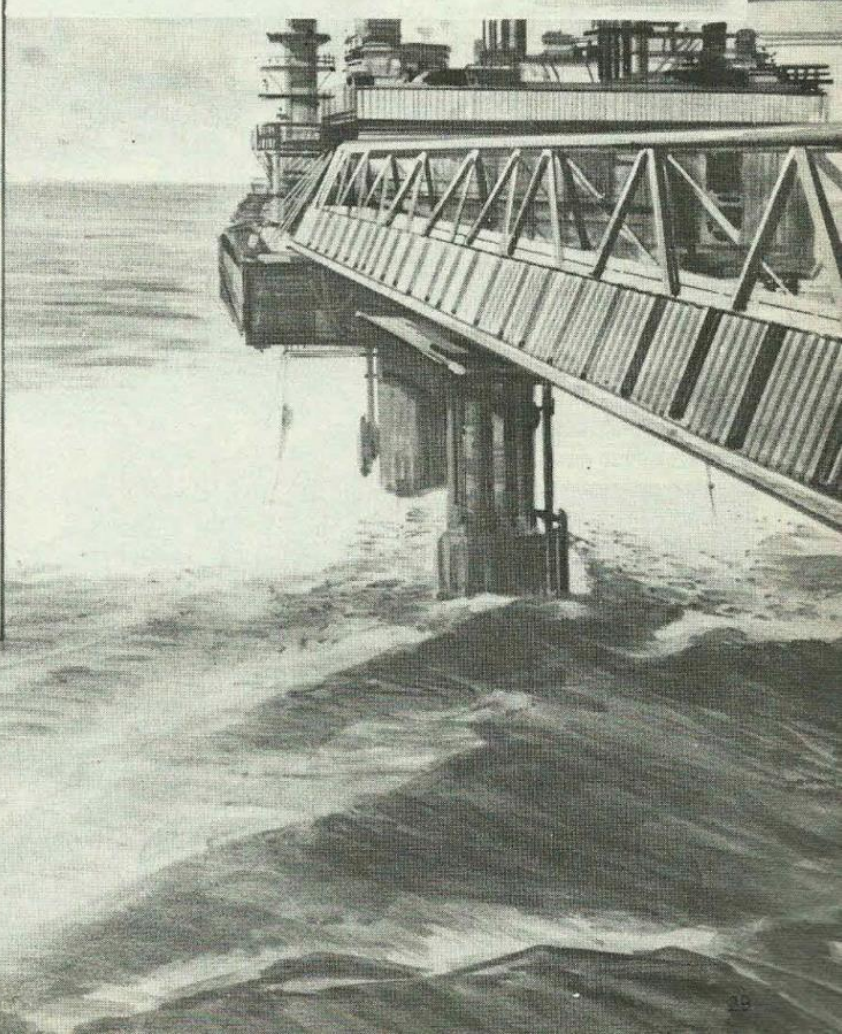


NEW HORIZONS IN HOLOGRAPHS

Full-length feature films using holographic techniques — three-dimensional pictures projected by laser beams — may shortly become a reality in our cinemas following a breakthrough by Soviet scientists. A few months ago they demonstrated in Moscow a 30-second monochrome film to a select audience, who saw the first moving hologram projected in space. So far only four people at a time can view the images, but experiments are in hand to produce three-colour images on full-sized screens.

DANCING ON THE NORTH SEA

A dance floor is planned as part of the accommodation of one of the latest North Sea platforms, which will be installed in the Norwegian sector. And the platform will do no drilling! Instead, the platform, which will be fitted out to the highest standards of any in the North Sea, will include a cinema, garden and bar in addition to the ballroom. But although it is a place of rest and recreation, work is not far away — it is designed to house North Sea oil workers, and a catwalk will link it to the drilling platform.



215/R

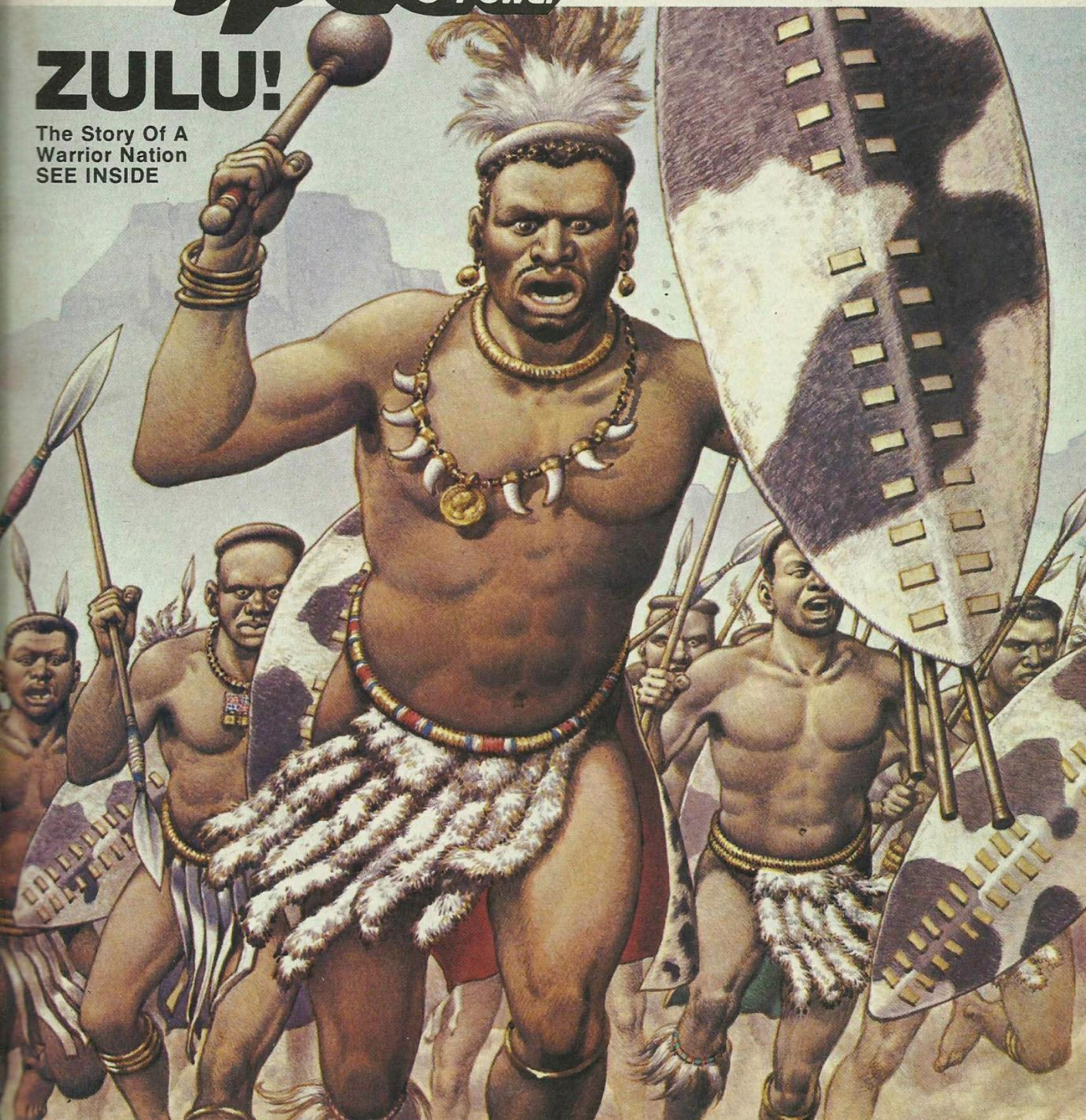
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ZULU!

The Story Of A
Warrior Nation
SEE INSIDE



With four wheels at the front and two at the back, it is no wonder that an outstanding new car is being hailed as...

THE SUPER SIXER OF THE 'SEVENTIES

MANY of the lessons learned by the designers of racing cars have been passed on to the family motorist over the years — disc brakes are a typical example — and the ordinary saloon car has benefited greatly.

It is not often, however, that a designer decides to

build a road car that incorporates several features of a Formula 1 racing car. But Bob Jankel, managing director of Panther Cars of Byfleet, Surrey, has done just that. The result is a sports car which looks like being one of the best in its class.

Called the Panther Super

Six — because it has six wheels like the Tyrrell P34 racing car — it may well be an outstanding car of the 1980s. It grew out of Bob Jenkel's desire to build a touring car which had spacious accommodation, good visibility for the driver and plenty of power, yet was easy to drive in town traffic.

The result is an amazing, eye-catching car. It's most outstanding feature is its wheels — four at the front, and two at the back. The steering wheel turns the forward front wheels, while the rear front wheels are moved simultaneously by a linking mechanism.

All four of the front wheels have disc brakes, and the designer has arranged for the two nearest the front of the car to lock before the others. The idea behind this is that the leading pair of wheels sweep away any rain on the road, thus enabling the others to increase their grip. The two rear wheels also have disc brakes. They are larger in diameter and have wider tyres to give a

Powering the Panther two-seat, six-wheeled tourer, shown here, is a Cadillac 8.2 litre V8 engine with twin turbochargers.

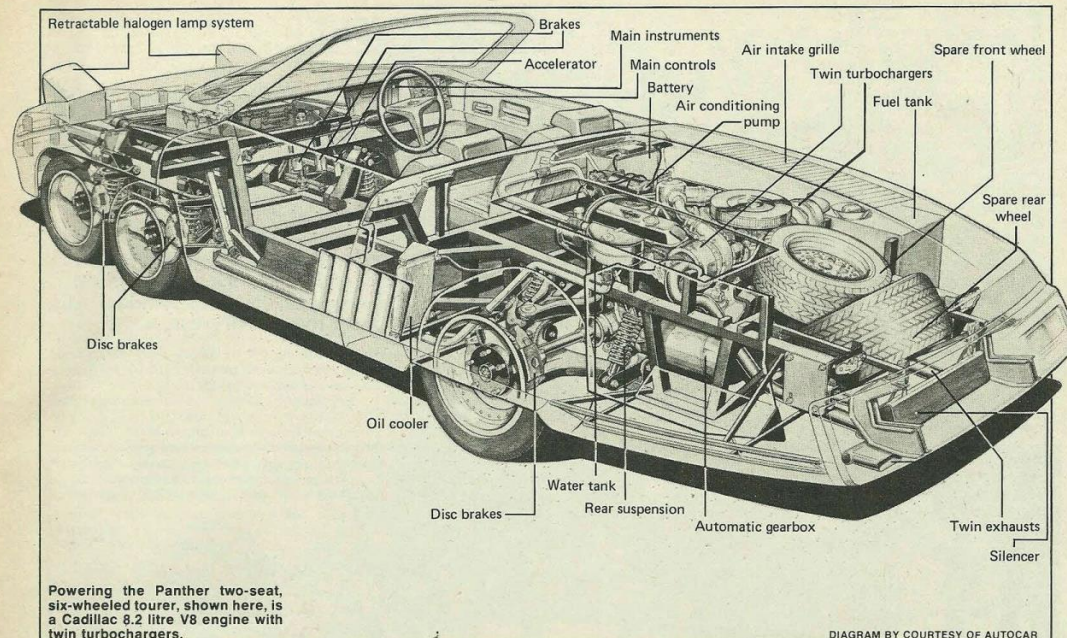


DIAGRAM BY COURTESY OF AUTOCAR

better road grip for the powerful eight-cylinder engine.

The engine, an American V8 (the cylinders are banked together in two lines of four in the shape of a letter 'V'), is the biggest of its kind built for cars. It has a capacity of 8,200 cc — very nearly ten times the size of a standard Austin Mini engine — and is the power unit used in the Cadillac Eldorado.

Panther Cars calculate

that the power output of 600 bhp will probably move the Super Sixer from standstill to 160 km/hr (100 mph) in about seven seconds. In order to develop this tremendous power, the engine has twin turbochargers which can be switched in when they are required. The top speed of the car will be about 320 km/hr (200 mph).

Despite this power, the Super Sixer's automatic gearbox will make it easy to drive at the slower speeds needed for city traffic conditions, and indeed make the car a gentle giant in every situation.

The massive power unit is placed almost exactly over the rear axle, where its weight helps to increase traction. Although the short nose of the car has no engine in it, it contains the big air-conditioning unit which is needed when the Panther is running as an open car in hot countries.

In cold climates there are two separate heaters, one for defrosting and the other for warming the cockpit interior.

In front of the air-conditioning unit is the engine radiator, which has twin electric cooling fans.

The car also has two other radiators just in front of the rear wheels. One of these is for cooling the engine oil, and the other is for cooling the automatic transmission fluid.

The car has twin fuel tanks on either side of the car. Each holds 70 litres (15½ gallons) and they are joined by a pipe which keeps the fuel levels even. Other exceptional items of equipment include electric window lifts, and a radio telephone which is fitted into the door. The windscreen

contains a built-in radio aerial, while the glass of the screen is tinted so that it is darker near the top.

A car like the Panther Super Sixer will obviously cost a great deal of money. So far, only the prototype has been built, and you are not likely to see one on the roads of Britain for a while, as production is not expected to be more than one a month.

After all, supercars are not mass produced. They have to be built with extra care — by hand.

LOOK AND LEARN MECCANO COMPETITION RESULTS

In November we featured a two-part competition in which readers were asked to select the correct names for eight photographs of famous bridges, and to tell us in not more than 10 words why they liked reading LOOK AND LEARN.

The answers were:

1 - E; 2 - C; 3 - B; 4 - H; 5 - D; 6 - F; 7 - J; 8 - G.

Having judged tie-breakers on all correct entries, the judges decided that the best received were those submitted by Edward John Bradshaw, Knaresborough; Ellen Cleaver, Tamworth; Anne Firth, Hinckley; Giles Hunt, Kingston on Thames; Alistair Parker, Co. Down. Each of our five winners receives £100 with which to buy Meccano parts of their choice.

Illustration by Brian Johnson

LOOK LEARN

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No. 842, 4th MARCH, 1978.
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THE FLYING FERRY

See Inside



Speed & Power

THE FLYING FERRY

This is the Jetfoil, which flies across the waves propelled by the water beneath it

An exciting new form of cross-Channel transport has joined the hovercraft and conventional ferry ships which carry passengers between Britain and the continent of Europe. It is a high-powered hydrofoil vessel that has been designed and built by the Boeing Aerospace Company of America, who are also well-known for building the great 707 airliner and the 747 Jumbo Jet.

Boeing's new sea vessel is called the Jetfoil. Several of these remarkable craft are operating in such other parts of the world as Hawaii, Japan and Hong Kong, where passengers who travel in them have described the sensation as rather like "flying just above the surface in an aeroplane."

The cross-Channel service, which uses the only Jetfoil in Europe at the moment, is operated by the old-established British shipping company, P &

O. Leaving its berth just below the Tower of London, the Jetfoil rises on its "wings" and skims down the River Thames, before crossing the North Sea on its way to the Belgian port of Zeebrugge. The journey takes about three-and-a-half hours.

The principle of the hydrofoil is a simple one which has been known for some time. In fact, the first experimental hydrofoil was steam driven, and ran on the River Seine near Paris in 1891. It was designed by a Frenchman named Count de Lambert. The Americans Wilbur and Orville Wright, who were the first men to achieve powered flight, also made some runs with a hydrofoil in 1907.

At low speeds, a hydrofoil floats in the water like an ordinary boat, but as it gathers speed, the hull rises out of the water on to small, wing-like structures that extend below its hull. The main part of the vessel is then hurtling through the air,

and because air is much less dense than water, less power is required to thrust it along. In fact, only about half the horsepower is needed to drive a hydrofoil when it is riding on its "water-wings", that would be needed by a conventional speedboat moving at a similar speed.

The Boeing Jetfoil has fully-submerged foils, while some other similar vessels have surface-piercing foils which make use of an inclined wing to lift the hull clear of the water. Although the surface-piercing type are effective, they are subject to wave action in rough seas which affect the stability of the vessel.

The fully submerged "wings" of the Jetfoil lift the hull well above the waves while remaining below their disturbing influence themselves, thus giving the vessel freedom from the motion of the sea's surface. Like an aircraft wing, the foils

have a hinged trailing edge which, when depressed or raised, increases or decreases its "lift".

In addition to this advantage, the "wings" or foils are connected to an automatic control system (ACS) that employs attitude and motion sensors. Even in quite severe sea conditions, the equilibrium of the hull is maintained to a remarkable degree, and passengers experience very little vertical or rolling motion.

Twin gas turbine engines of 3,700 hp each power the Jetfoil, which has no propellers. Instead, the engines drive high-performance pumps that force water through nozzles at the rear of the craft (see diagram), and give it a top speed of 48 knots in calm water, and a speed of 45 knots in a sea with 12ft (3.65m) waves. Normal cruising speed is 43 knots.

The foil system is fully retractable, rather like the

undercarriage of an aircraft, so that, when the vessel is operating in shallow harbour waters, it can easily be manoeuvred up to a quayside to take on and discharge passengers.

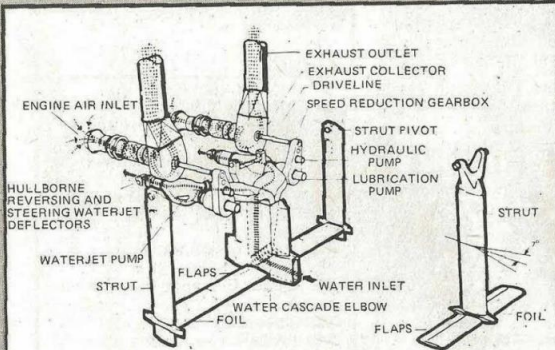
The foils are clad with stainless steel shields which absorb the impact of any floating debris the Jetfoil may strike at speed. The makers claim that the struts will slice cleanly through logs up to 14 inches (350mm) thick. Should the struts supporting the foils strike more solid objects, they have a "fail-safe" device which allows them to fold up against the hull. With struts fully retracted the Jetfoil can travel like a conventional ship, but at about one third the speed.

The P & O Jetfoil has two decks for passengers, and carries 212 people with their baggage. Other versions can take 420 passengers on short haul commuter routes. The passenger decks have comfortable

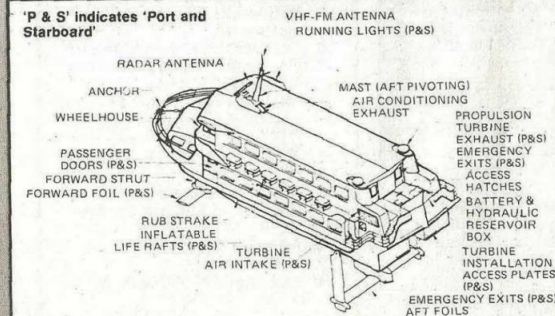
seating and they are air-conditioned. There is also a small food and drinks bar.

Because the decks are well above the water level, there is no spray to obscure the view and almost no vibration from the smooth-running turbine engines. Unlike the hovercraft and conventional ferries, the Jetfoil cannot at present carry any vehicles, and in a calm sea is slightly slower than a hovercraft. But it comes into its element in seas like the Channel and the North Sea, where are rarely calm.

The London-Zeebrugge run is still on a trial basis. The Jetfoil has proved its worth in the heavy seas around Hawaii, but the North Sea, where the waves are much closer together, is notoriously rough. If the test period proves successful, the sight of a Jetfoil winging its way across the water may become a commonplace around our shores.



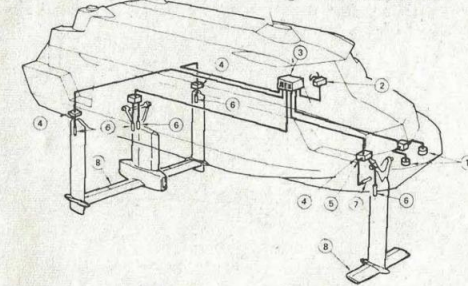
The motive power for the Jetfoil is provided by two gas turbine engines. Water is drawn in from an inlet on the foils and then pumped through waterjet nozzles. The craft has no rudder, but is steered by deflecting the jet of water.



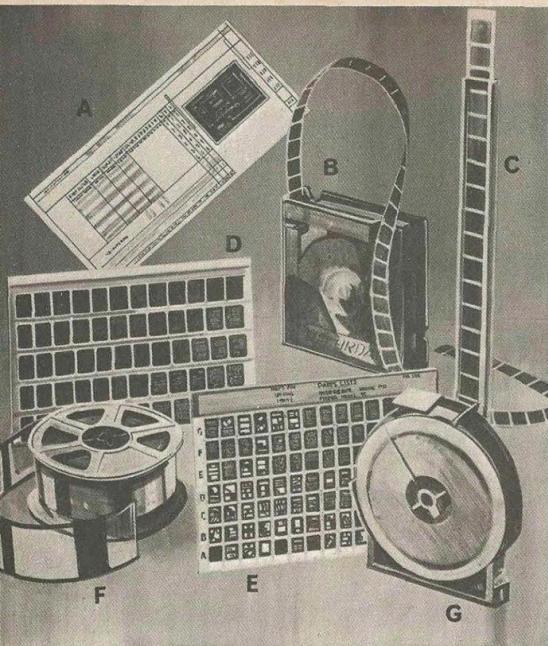
The Boeing Jetfoil. Cruising Speed: 43 knots. Displacement: 110 tons. Length: 90 feet (27.4 metres). Beam: 31 feet (9.5 metres). Draught: foils down 17 feet (5.2 metres), foils up 5.5 feet (1.7 metres). Propulsion: gas turbine — waterjet. Capacity: 190-420 passengers.



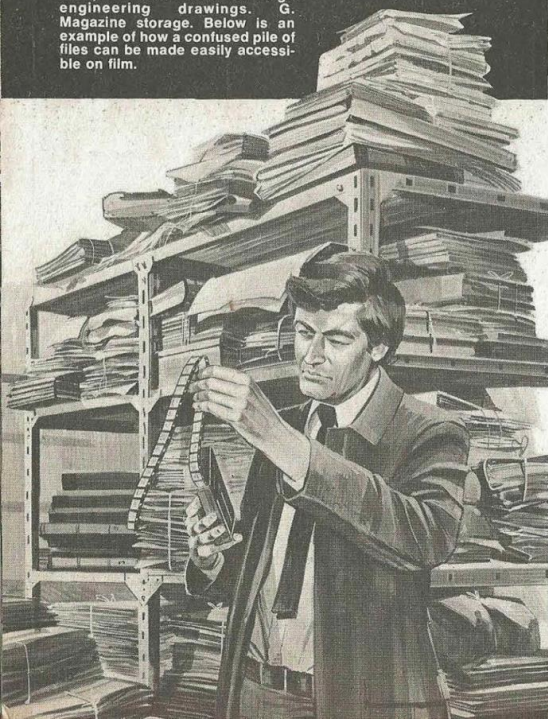
- 1 SONIC HEIGHT SENSORS (2)
- 2 HELM, HEIGHT COMMAND, CONTROL PANEL WITH HEADING HOLD AND FOILBORNE READY SYSTEM
- 3 COMPUTER, GYROS, POWER SUPPLY AND SELF-TEST SYSTEM
- 4 VERTICAL ACCELEROMETERS (3)
- 5 LATERAL ACCELEROMETER
- 6 FLAP SERVO ACTUATORS (5)
- 7 STRUT STEERING SERVO ACTUATOR
- 8 TRAILING EDGE FLAPS



When foilborne — up on the foils — the Jetfoil is controlled by its Automatic Control System. Craft motions are sensed by gyros, accelerometers and height sensors. The signals go into a computer which flashes out directions to the flaps on the trailing edges of the foils.



Thick office files and bulky volumes can be converted into micro-film and stored in the ways shown here. A. Card file. B. Magazine storage for reel of 16mm film holding 2,500 images. C. Strip-holder. D. Jacket for small strips and separate images. E. Sheet of micro-film (micro-fiche). F. 35mm reel for large engineering drawings. G. Magazine storage. Below is an example of how a confused pile of files can be made easily accessible on film.



SCIENCE AT WORK

DATA IN A DOT

It is the year AD 2000. Through the letter box pops a holiday brochure. With thoughts of happy days to come, you hurry into your sitting room to study it. But instead of taking a glossy, coloured publication from an envelope, you slip a film cassette out of its plastic holder and slot it into a box-shaped machine that resembles a television set. Soon, projected on to a screen in the front of the set are enlarged pages of pictures and print, telling you everything you want to know about your favourite holiday places.

The screen you are watching is part of a viewer specially designed to enable you to read a brochure which has been reproduced on film of microscopically small size which crowds many pages into an unbelievably tiny space.

Although it is a thing of the future — perhaps not as far ahead as 2000 — for people to have micro-filmed books in their homes, the use of microfilms by business concerns is a thing of today.

The big advantage of microfilm in business is the amount of space it can save. Records on microfilm need as little as 2 per cent of the space occupied by the same records on paper. A small cassette containing 30 metres of 16mm film can record 2,500 pages of print. Each of these pages is photographed, the images being reduced in size by lenses that focus on the film.

Several ways have been devised for storing microfilm. These depend upon the way in which it is going to be used. Most microfilm is exposed by a camera in roll form. These rolls can be easily indexed and stored to provide a permanent record. The originals, office files perhaps, can then be destroyed. To guard against the record being lost through a fire, a second copy of the film can be made and stored in a different place.

Magazines or cassettes containing the microfilm serve as labelled containers which protect the film and are easily found in a file. Transparent jac-

kets holding the small strips or even single frames of microfilm images provide another method of storage. Each of these can hold up to 70 images, and a hundred of these jackets is only about 12mm thick.

Similar to the jacket is the microfiche which can contain up to 500 images. Another type of microfilm storage is the strip holder in which one to ten strips of microfilm can be inserted. These are used where quick and easy reference to information is needed.

At the heart of all the microfilm systems is the retrieval apparatus. This is the equipment which enables the printed matter to be located in its file and projected in a viewer so that the reader can study it.

Once you have photographed perhaps a million documents, how do you set about finding the one you want? This is done with the aid of several coding techniques. Numbers or lines are printed on the film when the documents are being photographed. These provide an index.

EASY SYSTEM

After the appropriate magazine or microfilm has been identified by its typed label, it is placed in a microfilm reader. Then the film is advanced until the reference number or code line appears on the reader's screen.

In contrast to this, some systems are fully automatic. All the operator has to do is adjust the controls to indicate the reference codes of the matter he wishes to read, and the machine will then advance the microfilm until the desired image appears on the screen. This can happen within seconds of the microfilm being placed in the reader.

A typical microfilm storage and retrieval system consists of a rack in which the cassettes are stored. The operator sits before the viewer into which she places cassettes selected from the rack. To her right is a searcher keyboard on which she taps out the code for the document she wishes pro-

duced. Within seconds, she is seeing the document on the screen in front of her.

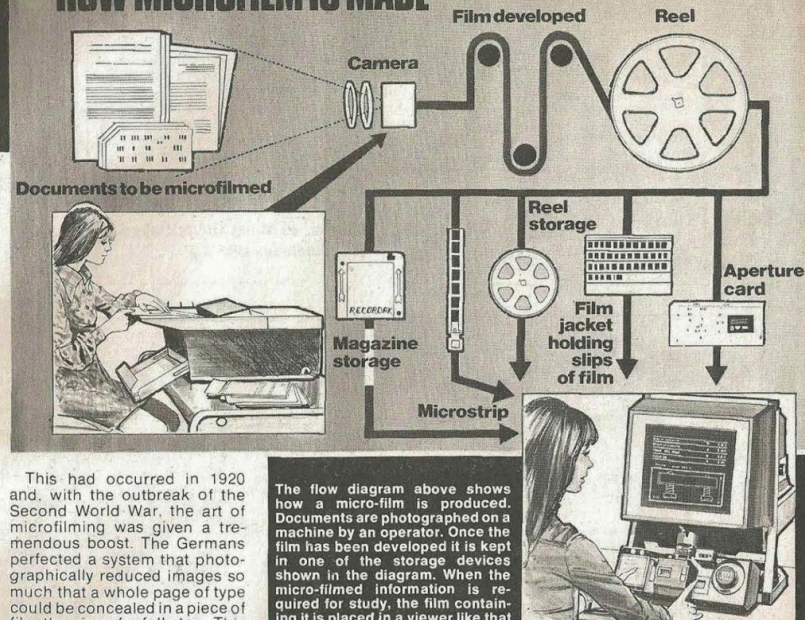
The use of microfilm in conjunction with computers is one of the latest developments. Instead of the computer's data being printed on paper, the information is conveyed by an electron beam to microfilm which does not need normal photographic processing. This system can record up to 20,000 lines of printed matter in one minute.

The future for microfilm techniques looks very bright. It could be only a matter of years before — as suggested at the start of this article — we are using microfilm readers in our own homes. At the moment the cost of such a system is prohibitive for most families. But once a cheap, portable microfilm reader has been made, we could use microfilms for reading books, studying, taking correspondence courses, choosing wallpaper and carpets and the holidays we want to go on. There could come a time when newspapers and magazines will be produced on microfilm and sent through the post attached to a card no larger than a playing card.

Although this seems like a peep into the future, microfilm techniques are not new. The first known microphotograph was taken more than 130 years ago by a British instrument maker, John Dancer, who reduced a document half-a-metre high to little more than a pin head. Thirty years were to pass before the technique was used for communication. It was then that a French photographer sent microfilm messages over the walls of Paris to besieged defenders during the Franco-Prussian war.

Modern microfilming techniques were invented by an American banker who wanted a record of cheques being returned to depositors or forwarded to other banks. He devised a machine, the forerunner of modern microfilmers, which did away with the need for laboriously handwritten descriptions of cheques.

HOW MICROFILM IS MADE



The flow diagram above shows how a micro-film is produced. Documents are photographed on a machine by an operator. Once the film has been developed it is kept in one of the storage devices shown in the diagram. When the micro-filmed information is required for study, the film containing it is placed in a viewer like that on the right. An enlarged reproduction of the film appears on a display screen. The picture below shows a micro-film storage and retrieval system. Cassettes are stored in a rack (left). A searcher keyboard is programmed by the operator with the code for a certain document. The machine automatically advances the film until the appropriate image appears on the reader. Along the edge of the micro-film at the bottom of the page are coding marks which enable specific frames to be found speedily.

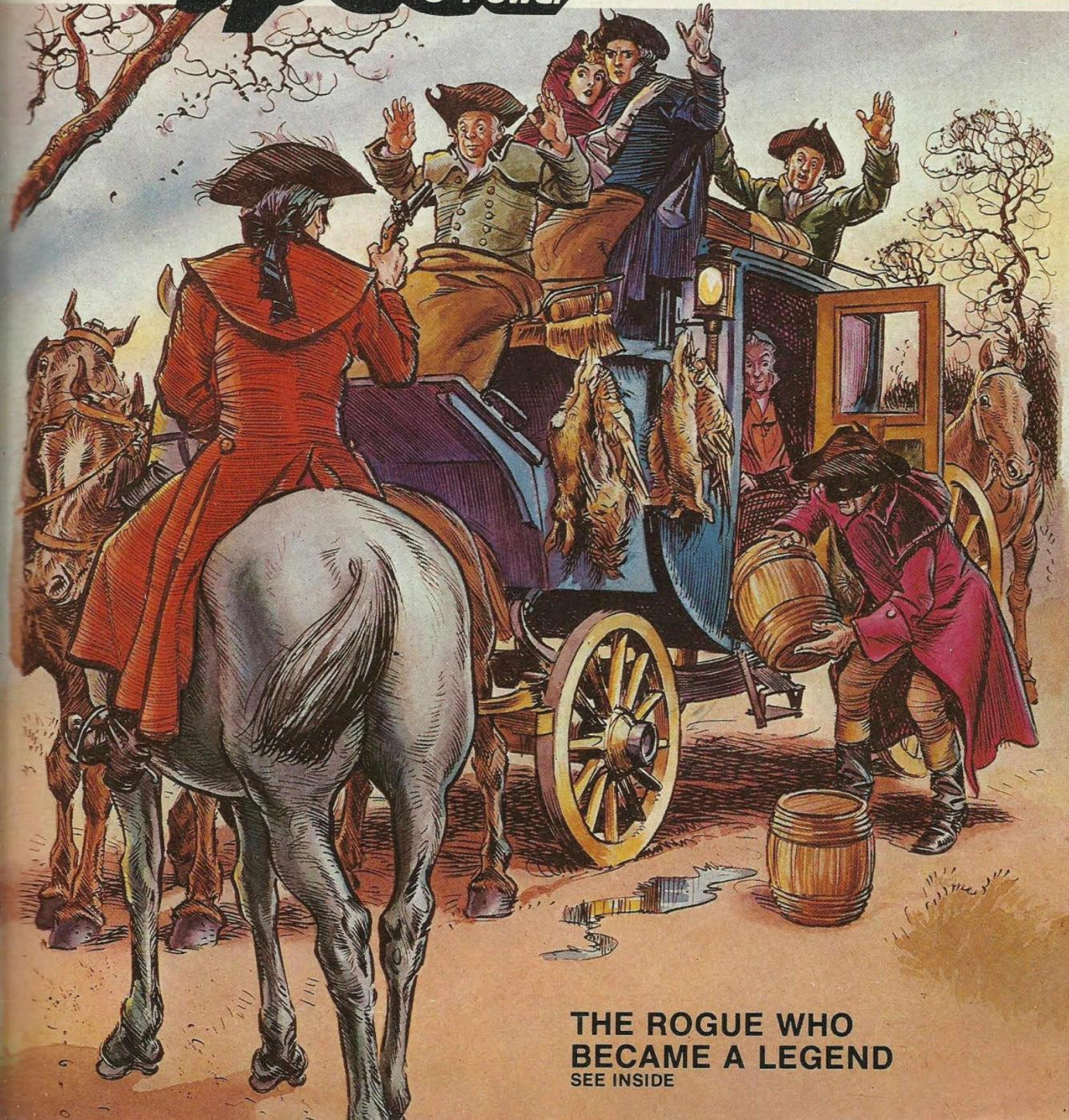


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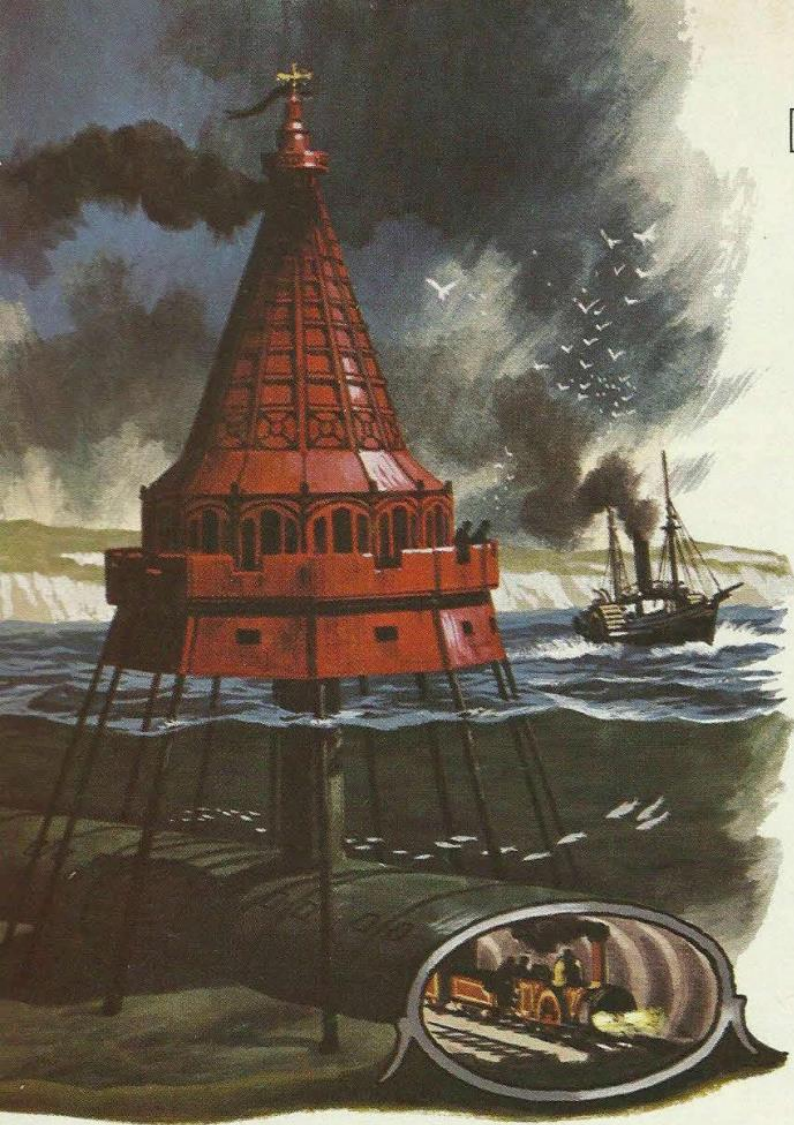
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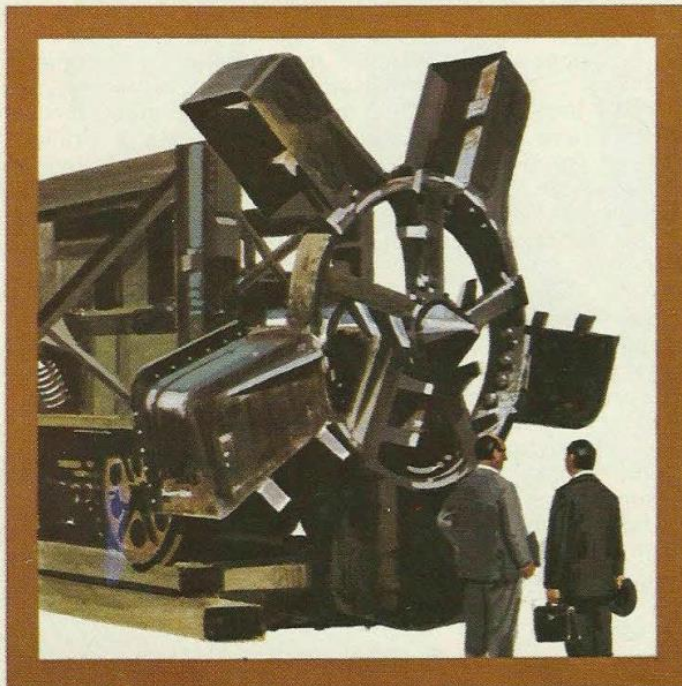
**THE ROGUE WHO
BECAME A LEGEND**
SEE INSIDE

THE TUNNEL THAT NEVER WAS

For over a century, engineers have dreamed of linking Britain to the Continent by means of a tunnel. Why was the tunnel never completed — and have today's huge costs killed the project forever?



Here are two examples of Channel tunneling methods devised by engineers in the past. The one above is Hector Horeau's 1851 design for an oval, twin railway tunnel half-buried on the channel bed with towers for ventilation spaced along it overhead. The House of Commons formed a channel tunnel committee in 1909. One of the results of their deliberations was the digging of trial borings near Folkestone in 1922-23. For this, the Whitaker machine, below, was used.



Illustrations by Wilf Hardy

A tunnel beneath the English Channel? Napoleon liked the idea. As Emperor of France he had everything to gain and nothing to lose from a road link between his country and Britain.

But the British people did not share his enthusiasm for such a revolutionary project. For centuries, the people of Britain had felt secure behind the strip of water that separated their land from Europe. And Napoleon's ambitions towards greater and greater power were well known.

It would be easy for him to march his troops through the tunnel.

And so Napoleon's proposals, which he made to the British ambassador at the beginning of the 19th century, were turned down.

Similar ones were raised in 1876 when Britain and France finally came to an agreement to link their two countries with a tunnel. They even went so far as to dig experimental tunnels for 2,000 metres on either side. But the work was stopped in 1882, probably because of the cost and of Britain's fears about the use an invader could make of the tunnel.

The idea came up again in 1914 but was stopped as World War One broke out.

In 1975 the government again abandoned the idea of a tunnel after proposals for one had been made in a White Paper. This was to have been a joint project by the British and French governments. The cost of the tunnel was to have been £846 million. It was finally scrapped because of soaring costs and the economic crisis.

The basic plan consisted of two transport tunnels, each 7.3 m in diameter and spaced 22 metres apart, through 53 km of chalk beneath the sea bed.

Between them and connected to them by passages was to have been a smaller ser-

vice tunnel which could also have acted as an emergency escape route.

Passenger and goods trains were to have used the main tunnels. These would carry cars and their occupants.

A geological survey had shown that this project was technically feasible, and there is no doubt that the tunnel would have been busy. The experts were even saying that there would have been a need for a second tunnel by 1990.

Another favoured idea was for a concrete tube laid in a trench dug in the bed of the Channel. Prefabricated sealed tubes would be lowered into previously scooped out ditches from moving installation equipment. The sections would be joined up and the seals removed.

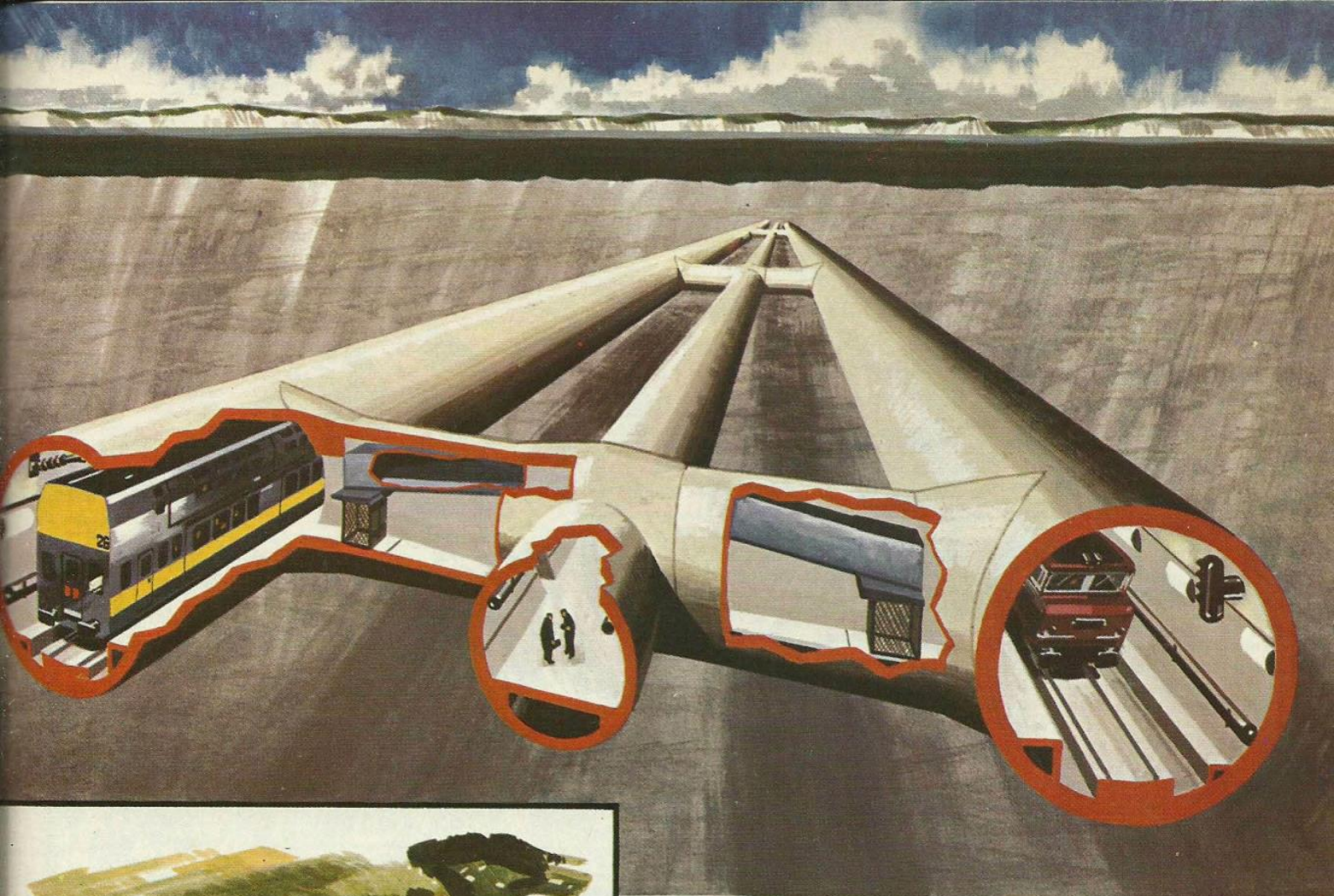
This operation could be carried out from huge platforms carrying all the necessary equipment and mounted on tall legs resting on the sea bed. The platforms could be moved forward as the work progressed.

Each of these platforms would be like a table with a pull-out extension passing right through it from front to back.

Imagine the main centre platform standing squarely on its legs. The extension driven by motors is pushed forward. Then the extension drops its legs down; the centre section raises its own legs and moves forward along the extension.

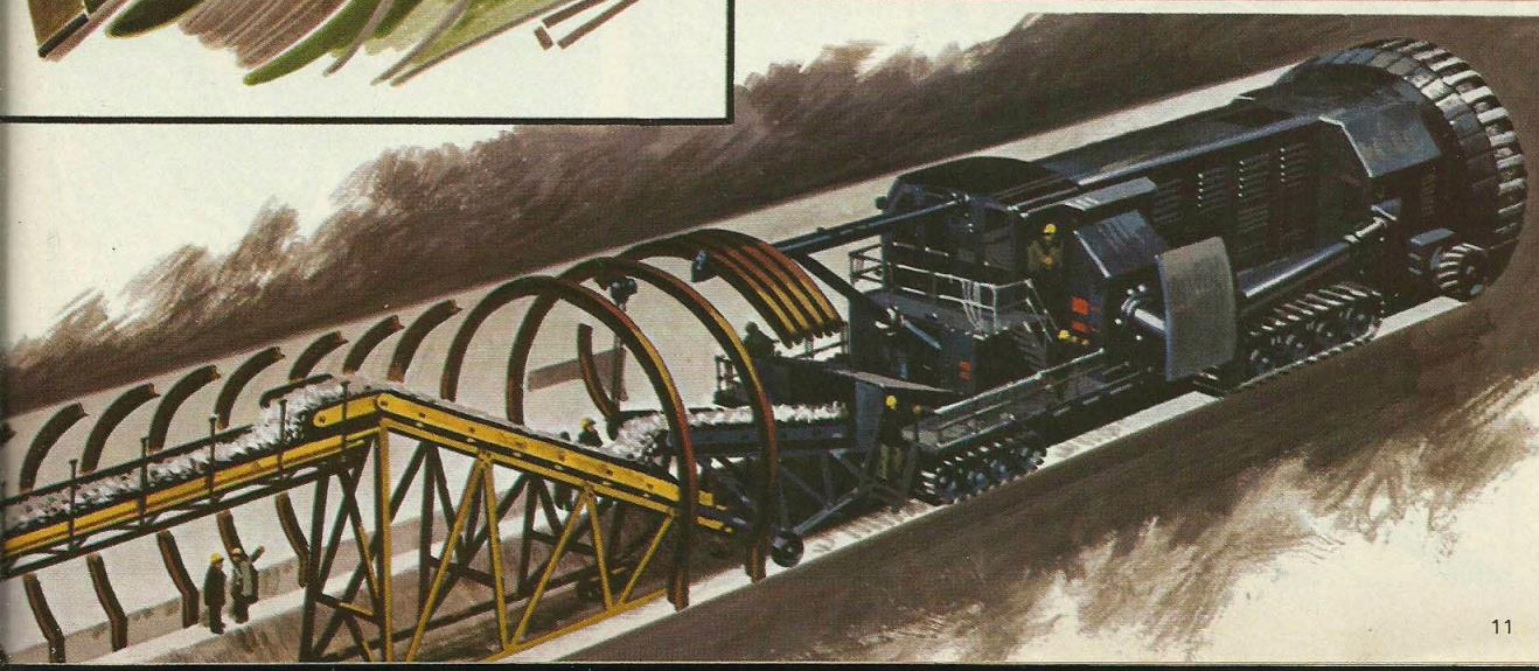
Two sets of this apparatus would be used, one to carry machinery to cut a trench and the other to carry the tunnel sections and lower them.

This, however, is all part of a dream which may never come true, for while the idea of a channel tunnel is appealing, its cost, the disruption it would cause with the construction of approach roads and the dangers of sabotage could make it impracticable.



A DREAM THAT COULD HAVE COME TRUE . . .

Above is an artist's impression of how the tunnel, abandoned in 1975, could have been built. There were to have been twin rail tunnels and a central service tunnel for ventilation and maintenance and for use in emergencies. Cross-tunnels were to connect the two main tunnels every 250 metres (280 yards). A terminal like that on the left at Cheriton, near Folkestone in Kent, would have connected the tunnel to the existing rail and motorway network. Tunnel boring could have been done by a machine like that below. It could have cut easily through the chalk, which would have been conveyed back down the tunnel as it was dug out.



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LOOK AND LEARN

INSIDE

No. 844, 18th MARCH, 1978
EVERY MONDAY PRICE 20p.

Part One Of A Great **101 THINGS TO DO** Pull-Out Booklet



THE WORLD OF SPEED AND POWER

Illustration by Will Hardy

Five turbine engines, 48 separate air cushions and five years' technical study have all gone into the latest...

CROSS-CHANNEL GIANT

HOVERCRAFT — or Air Cushion Vehicles (ACVs) as they are sometimes called — are now firmly established as one of the world's successful forms of transport, and one which is particularly useful for short-haul work, where medium-sized loads need to be carried quickly across stretches of open water.

One route on which hovercraft have been tried and tested with considerable success for a number of years is the cross-Channel journey between Britain and France, where the world's first ACV car-carrying service began in August, 1968. Seaspeed, a subsidiary of British Rail, started the service with a giant Mountbatten Class hovercraft called *The Princess Margaret*, and followed it up a year later with a second one — *The Princess Anne*.

Between them, these two hovercraft have ferried five million passengers and about 775,000 cars across the English Channel between Dover and Calais, and Dover and Boulogne. Now, a super-sized hovercraft — the biggest in the world — will be coming into service during the summer of 1978.

This is the 240-tonne Sedam N-500, a French-built ACV, which will be able to carry up to 400 passengers and 65 cars, more than double the load carried by the standard Mountbatten Class. It will also be able to carry five coaches on a raised central section.

The N-500 "Naviplane", as the French call it, is the result of five years' technical study and six months' technical trials. Fifty metres in length and 23 metres wide, it is the first of an entirely new generation of hovercraft and differs greatly from the existing British Mountbatten Class.

Although they are fast — the N-500 will reach 70 knots on fairly calm days — hovercraft have some disadvantages. They can be difficult to steer in a strong side-wind, and they throw up a lot of spray which blocks the passengers' view.

New Cushion System

The designers of the N-500 have dealt with these two problems by fitting a completely new type of air cushion. Instead of using one huge single "skirt", they have built 48 separate cylindrical skirts, each of which has a separate air supply. Complicated pipework supplies air to groups of cushions, and the pressure can be altered by the pilot to adjust pitch and roll to suit the weather conditions.

Five engines power the N-500: two provide lift, and three are for propulsion. The forward propulsion engines are mounted on a gantry high above the water. As they are directly connected to their propellers instead of through drive-shafts like those of the

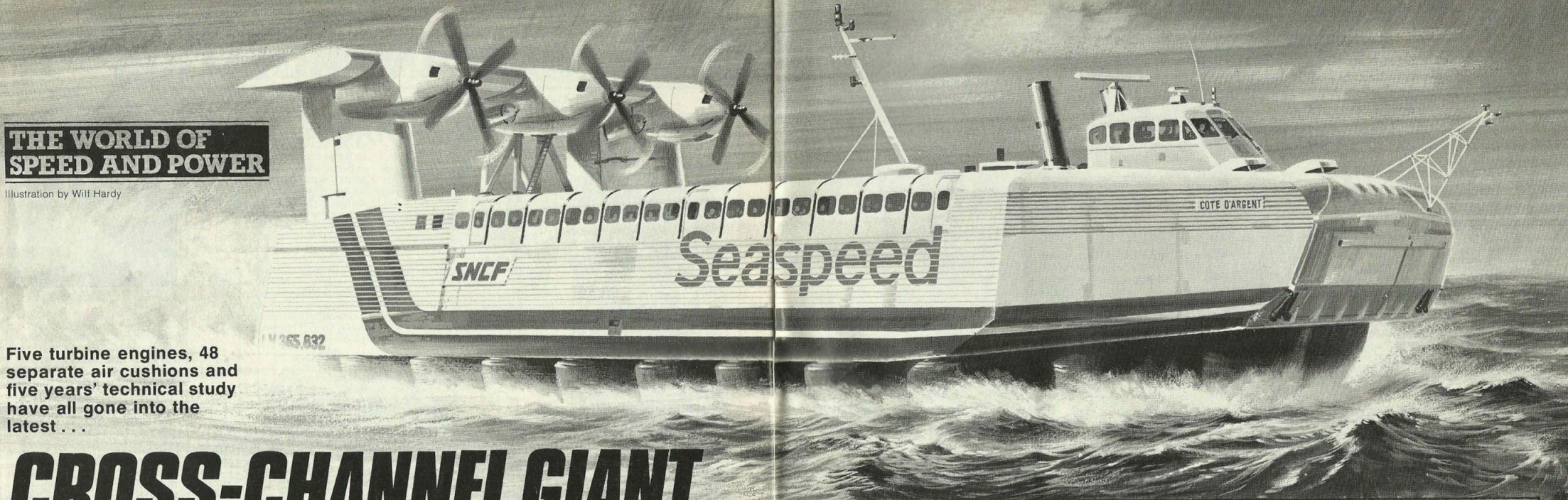
Mountbatten Class, there is a considerable reduction in noise and vibration.

The engines are Marinsed Lycoming TF 40 turbines with a maximum continuous horsepower of 16,000. The drive propellers are made by the British Hawker Siddeley company and are 6.4 metres in diameter. Their pitch can be varied, and even reversed, to increase manoeuvrability. The passenger deck is also higher above the waterline than in any other hovercraft, so increasing visibility.

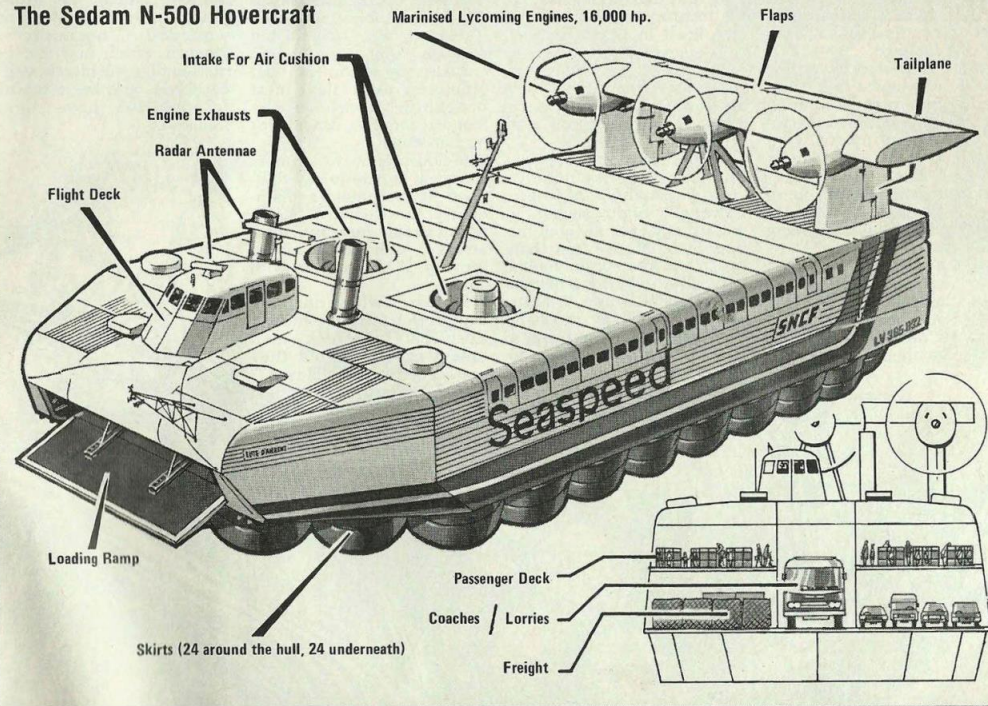
The N-500, which belongs to SNCF, the nationalised French railway system, will operate in conjunction with Britain's Seaspeed hovercraft which are themselves undergoing a complete transformation.

The two SRN4s are to be cut in half, and a 16.5 metre new centre section fitted which will increase their overall length to 55.5 metres.

In addition to lengthening the Mountbatten Class hovercraft, the rebuilding will also involve the realignment of the transmission system, the redesigning of the inner cabins and the fitting of additional seats. The Proteus jet engines will be uprated to 3,800hp, and new propeller pylons will be fitted. The "stretched" hovercraft will be able to carry 416 passengers and up to 60 cars, thus matching the capacity of the French N-500.



The Sedam N-500 Hovercraft



215/R
THE MAGAZINE ALL THE FAMILY LIKE TO READ

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LOOK AND LEARN

No. 856, 10th JUNE, 1978.
EVERY MONDAY, PRICE 20p.

**THIS 'ELEPHANT'
HAS WINGS**

The Inside Story Of A Giant Airliner — ON PAGE 7

The Challenge Of The Blue Riband

The Thrilling Story Of The Transatlantic Steamers
Which Became Record-Breakers Begins Inside



EACH YEAR THOUSANDS OF NEWLY-BORN SEALS HAVE TO FACE...

The Season Of Slaughter

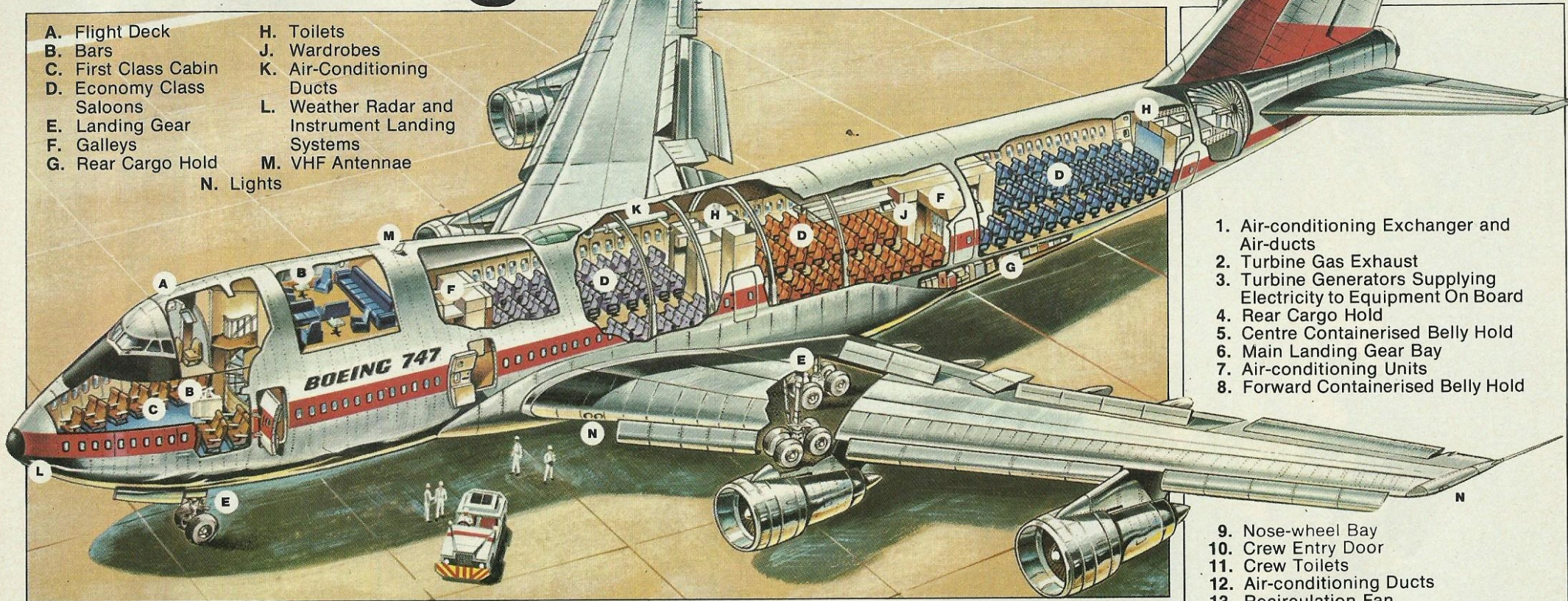
SEE PAGE 30

This 'Elephant' Has Wings

With a tail fin the height of a five-storey building, it is no surprise that the Boeing 747 aircraft is more popularly known as the Jumbo Jet — although even the largest of African elephants would be dwarfed by its huge bulk.

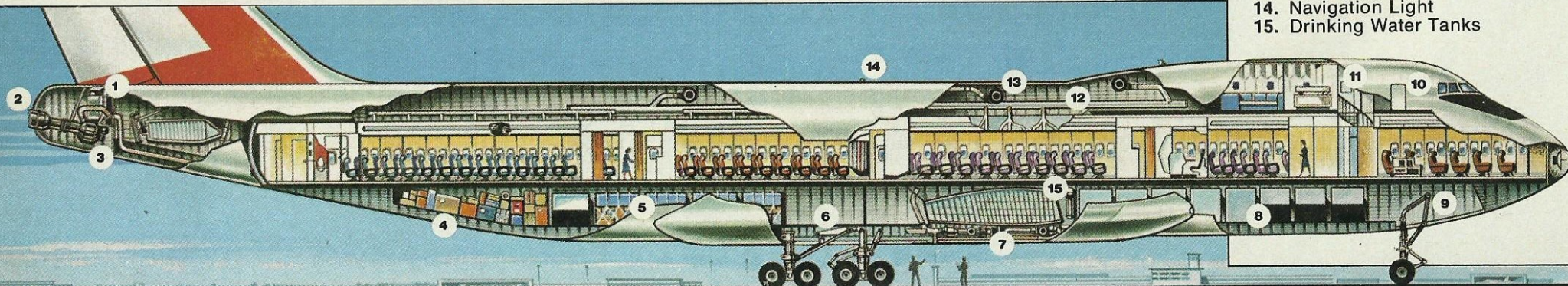
It can take up to 490 passengers and transport them over 10,000 kilometres in one non-stop flight. And while the passengers sit in air-conditioned comfort 10,000 metres up in the sky, an army of stewards and stewardesses attend to their needs. The only problem — equipping the airport terminals to cope with the simultaneous arrival of so many people!

DAN ESCOTT



1. Air-conditioning Exchanger and Air-ducts
2. Turbine Gas Exhaust
3. Turbine Generators Supplying Electricity to Equipment On Board
4. Rear Cargo Hold
5. Centre Containerised Belly Hold
6. Main Landing Gear Bay
7. Air-conditioning Units
8. Forward Containerised Belly Hold

9. Nose-wheel Bay
10. Crew Entry Door
11. Crew Toilets
12. Air-conditioning Ducts
13. Recirculation Fan
14. Navigation Light
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THE MAGAZINE FOR ALL THE FAMILY

LOOK AND LEARN

No. 869, 9th SEPTEMBER, 1978

EVERY MONDAY PRICE 20p.

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South Africa 40 cents, Canada 45 cents, Malaysia \$1.20.

The Price Of Victory

A Sniper's Bullet Claimed The Life Of A Hero — SEE PAGE 20

JOURNEYS OF THE 21st CENTURY

A NEW SERIES TAKES YOU ON A TRIP INTO THE FUTURE — SEE PAGE 6



YOUR WORLD TOMORROW

What will life be like in the future? Our new series takes you on a trip ahead in time.
THIS WEEK . . .

Journeys Of The 21st Century

SHUTTLE space-ships to the moon and beyond, huge hoverships sweeping across the seas, trains shaped like "flying saucers", tall-masted clippers and lazy dirigibles could well present the pattern of transport in the world of tomorrow.

The machines being designed today to carry people and cargo across the oceans and the continents as the new millennium approaches will not all be sleek and supersonic: it seems that the old and the new will be dovetailed into the transport systems of the future.

Already the signs are appearing. Trains will be revolutionised and so will rail networks in many parts of the world. In Britain, for instance, tests are about to begin on a 150 mph (240 km/h) train — the natural successor to the recently introduced high-speed 125 mph model. The West Country will be the first region to see the latest version tested out with the aim of speeding up even more British Rail's system over the main lines.

And somewhere in the pigeon-holes of a BR office lies a patent, bought for several hundreds of pounds, for a "flying saucer" — just like those imagined by science fiction authors. The plans envisage 22 passengers being seated in a circle, protected from the radiation of a thermonuclear engine by a disc-shaped shield.

Officially, British Rail say that the saucer idea is not being pursued because of costs, but significantly the patent has been

Dazzling new developments in transport will exist side by side with forms more familiar to our forefathers than to us

put in a safe place ready for renewed study whenever future developments are to be considered.

But within the realm of the possible are experiments under way today in West Germany, the United States and Japan on magnetically operated trains which float above a concrete guideway and can theoretically reach speeds of up to 500 kilometres an hour.

Japan is well ahead in this field with specially made tracks built about 8 metres above the ground and 5 metres wide. In the middle of the track is a perpendicular concrete guideway with coils on either side taking the place of ordinary rails to "float" and propel the train.

The train actually floats on the repulsion between magnetic fields in its base and others generated by electric current passing through the coils. By altering the magnetic fields in the bottom of each car, a magnetic vector is created causing the train to accelerate.

Japan is putting about £35 million into the plan, which it is hoped will be in full operation by 1981 with trains reaching 300 km/h. Greater speeds will come with more sophisticated equip-

For four years now, the German firm of Thyssen Henschel have been developing their electro-magnetic train on a test track in Kassel. Now a new, longer test run is being built, incorporating linear electric motors in the track. These interact with magnets on the train to hurl it forward at speeds of up to 400 km/h.

ment in the future.

Great changes in transport in the next 20 years are expected from the hovercraft, those leviathan ferries that ply between Dover and the ports on the northern French coast. While bigger and faster versions will appear, it will undoubtedly be in naval research that the greatest strides will be made.

Hoverwarships

The US Navy is spending vast sums of money on this British invention to produce super-hovercraft capable of carrying troops, tanks and missiles. It is believed that the US will be the first country to produce the first hoverwarships — 2,000-tonners with speeds of 100 knots. Such a craft could do the work of destroyers at three times their speed and is due to emerge from the naval workshops within a few years.

In Britain the air cushion principle is being adopted for many tasks involving a strange assortment of vehicles and platforms for accommodating passengers, cargoes and even for lifting heavy objects.

In air travel, the most drama-

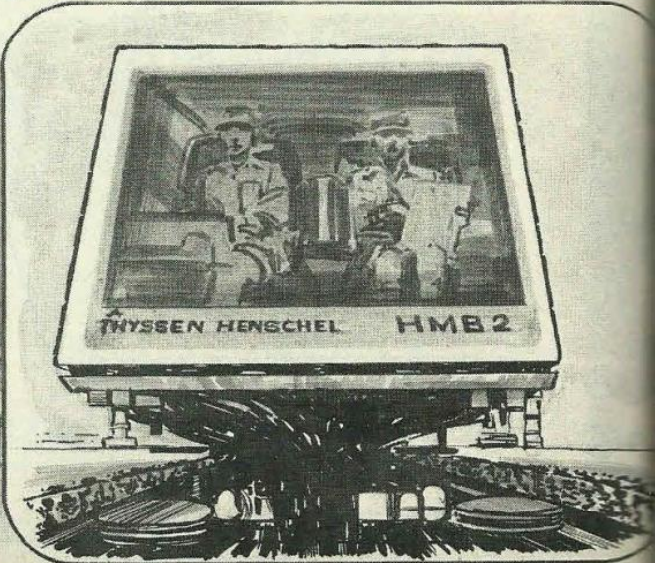
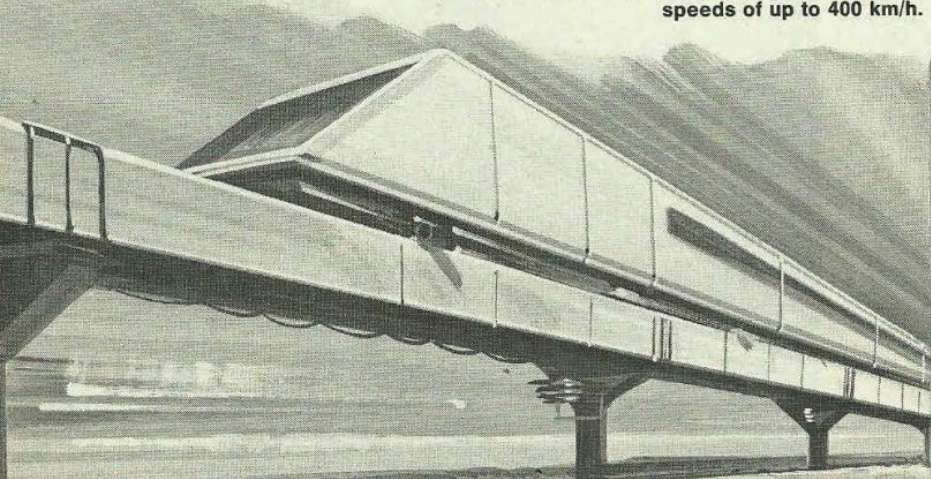
tic development will be the space shuttle plane that today rides piggy-back on a jumbo jet before being launched from thousands of feet above the earth. However, scientists are anticipating the next stage which will take place at Cape Kennedy when the shuttle blasts off by rocket power. It will be the first winged craft to orbit the earth — at over 20 times the speed of sound.

But while all these systems call for great expenditure, some transport designers are trying to cut costs and save fuel by adopting old time methods.

Some maritime experts argue that tall-masted ships like the tea clippers that operated between the South Seas and Britain at the turn of the century will make a come-back. They could lop two-thirds off the cost of running an ordinary freighter: the wind, after all, is much cheaper than oil!

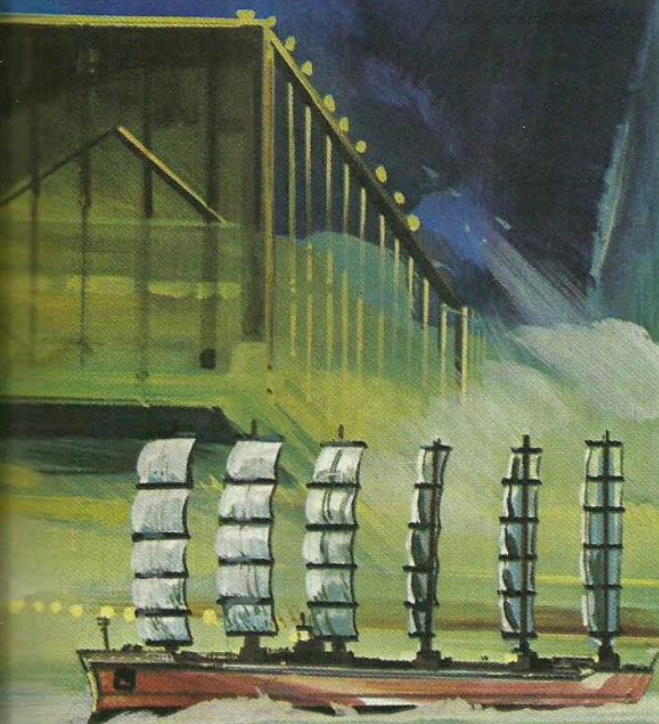
It is also being predicted that the cheapest way of air-freighting cargo is by using airships. Certainly, this idea has had the support of NASA — the National Aeronautics and Space Administration of the US — which has had studies undertaken into the feasibility of building an airship 1,656 feet (about 500 metres) long and powered by 16 gas turbo-prop engines beneath a frame containing 40 million cubic feet (over 1 million cubic metres) of helium.

Apart from carrying freight cheaply, the airship might well appeal to people not concerned with crossing the Atlantic quickly. By airship it would be a lazy, overnight affair.



GERRY WOOD

Right: our artist's impression of the NASA-Boeing "Powersat" space-craft, which is still on the drawing-board. It will be powered by a steam turbine system, the heat for which will come from giant 5-kilometre-wide bowl-shaped reflectors focussing the heat of the sun: huge landing basins will have to be built to enable the "Powersat" to make a soft landing on its return to earth.



Right: faster than most modern cargo ships, 60 per cent more efficient than the old sailing clippers, and completely pollution free would be the "Dynaships", the brainchild of a German engineer. A touch of a button will set and trim the sails in under the time it takes to draw a curtain. The secret of the Dynaship's efficiency lies in modern technology, allowing all the sails to catch the maximum possible wind at any one time.



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THE MAGAZINE ALL THE FAMILY ENJOY READING

LOOK AND LEARN

No. 870, 16th SEPTEMBER, 1978

EVERY MONDAY PRICE 20p.

**'SEND FOR
THE BRIGADE!'**

**SPACE~The
Final Frontier**

THE STORY OF THESE FEARLESS FIRE-FIGHTERS IS ON PAGE 28

SEE PAGE 6





THIS MADE HEADLINES

The Day England Won The World Cup

IT was a great and glorious day in the history of British soccer when England won the most coveted soccer trophy of all — the World Cup. The date on which this sensation occurred was 30th July, 1966.

The setting was Wembley and the 93,000 spectators went wild with excitement when, in the last seconds of the game, Geoff Hurst of West Ham took a long pass from Bobby Moore and propelled a rocketing left foot drive into the net of their German opponents from 20 yards.

With this goal, England established a 4-2 win over West Germany and earned the coveted cup. To get this victory, Geoff

Hurst scored a hat trick and became the first player to score three times in a World Cup final.

A world-wide audience of 400 million TV viewers in 29 countries watched the game and, at the end of it, saw England's captain, Bobby Moore, receive the cup — officially known as the Jules Rimet trophy — from the radiant Queen, accompanied by the delighted Duke of Edinburgh. Beside her was Sir Stanley Rous who, as president of FIFA — the international foot-

ball federation — shared England's proud moment.

Germany had been first to score, when Helmut Haller drove deep into the England net in the 13th minute of the game. Five minutes later, Hurst headed in England's equaliser.

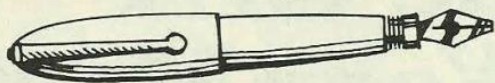
Although honours were even, the Germans were playing the more forceful game. Despite this, Martin Peters put England ahead in the 77th minute. But, just before full time, Wolfgang Weber evened the score for

Germany making it 2-2.

After this, the game went into extra time. Hurst scored again after 100 minutes (3-2) and, in the very last seconds of the game, Hurst slammed yet another goal for the jubilant English (4-2).

During this game, including the 30 stamina-sapping minutes of extra time, England proved that they had one of the fittest and strongest teams ever produced in English sport. A combination of sensible training routines, hard work, a careful and well-prepared diet, and team work that grew out of the weeks the squad spent practising together, gave them the victory they deserved.

THE LOOK AND LEARN Letterbox



A prize of £2 will be paid for each letter published. Readers' letters should be sent to the address below. No letters will be returned unless accompanied by a stamped addressed envelope.

A Very Special Cargo

Your article about the "Queens" wartime Atlantic crossings was very interesting as my Dad was one of the thousands of airmen who went across the Atlantic in the *Queen Elizabeth* for flying training in North America.

The *Queen Elizabeth's* catering was not too bad, as it had food from the States; and meals were served twice each day. My Dad sat between two airmen who were too sea-sick to eat, so every meal he had their food.

The port-holes were always closed to stop sea-water gushing in if the ship rolled too

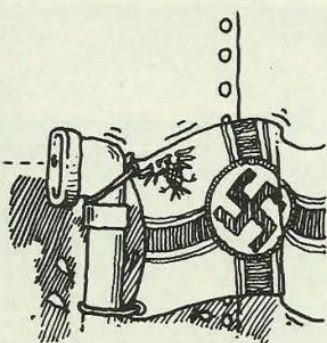
far to starboard or port, and also to hide the ship's lights from the enemy.

The only U-boat danger during my Dad's trip was when one was detected just ten miles away. It was much more dangerous when they entered New York harbour in thick fog among all the shipping.

The captain of one small craft called jokingly "What ship?" and in reply the *Queen Elizabeth's* captain called out "What city?"

So you see, the "Queens" had a very special cargo as far as my family is concerned.

Patrick O'Neill,
Newham, Glos.



Name: Yogendera Singh (male)

Address: T.C. 2/1745/1, "Ravi Krishna", L.I.C. Road, Patton, Trivandrum-4, Kerala, India. **Age:** 15

Hobbies: Stamp collecting, reading, swimming, pop music, and boating.

Name: Robert Jucker

Address: Box 137, Mandin, Natal, South Africa. **Age:** 12

Hobbies: Stamp collecting, motorbike riding.

Name: Frazer A. Kudawoo

Address: P.O. Box 86, Keta, V/R Ghana, W. Africa. **Age:** 17

Hobbies: Swimming and music.

Name: Joseph Jojoe Adams

Address: Cape Coast Technical Institute, Private Mail Bag, Cape Coast, Ghana. **Age:** 18

Hobbies: Pop music, football.

Name: Addai Thomas-Maxwell

Address: Acherensua Secondary School, (37 Karribo Hall), Box 5, Acherensua B/A Ghana, West Africa. **Age:** 16

Hobbies: Pop songs, photography.

Name: Daniel Argyei

Address: S.D.A. Secondary School, P.O. Box 45, Bekwai-Ashanti, Ghana, West Africa. **Age:** 17

Hobbies: Pop music, swimming, cycling, post cards, football, tennis.

Name: Tracey King

Address: 7 Alfred Road, Greendale, Salisbury,

Rhodesia, Africa. **Age:** 13

Hobbies: Sports, pop music.

Name: Christopher Hodge

Address: 11 Rover Road, Rondesbosch 7700, Cape Province, South Africa. **Age:** 15

Hobbies: Inventing dice games, table tennis and music.

Name: Owusu-Ansah Kennedy

Address: Acherensua Secondary School, P.O. Box 5, Acherensua B/A, Ghana. **Age:** 17

Hobbies: Travelling, photographing, dancing.

Young Ham

Although I am only 14 years of age, I am an operating radio amateur. I find my hobby both interesting and absorbing, and through it I have made friends all over the world.

One of the drawbacks of this hobby is the price of radio equipment. I own a short wave communications receiver which cost about £150. I built my own transmitter, and its components cost about £30. However, it is possible to buy second-hand equipment from the small ads columns of magazines like *The Short Wave Magazine*.

A licence is needed to operate a transmitter; to obtain a licence a person must pass a written exam based on theory and practice, and also pass an exam in morse code.

All you need then is a licence, which will cost you £3.50 a year. I bought mine last December.

Simon Young,
Wirral, Cheshire.

Clunk-Click Before Every Trip

One morning I was watching TV. An advert about wearing your seat belt showed a man getting shot through a sheet of glass at 30 m.p.h. You could go through your windscreen at 30 m.p.h. or more in a crash if you are not wearing your seat belt.

The same afternoon I saw a car crash into a wall. The men in the car were not wearing seat belts and one man went through the windscreen. The man was very badly hurt and we called an ambulance. I hope you and your parents always keep your seat belts on. Next time it could be you.

P. Balfe,
Ewhurst, Surrey.

Name: Junita Farina

Address: Box A.P.2., P.O., Airport, Salisbury, Rhodesia. **Age:** 13

Hobbies: Horse riding, stamp collecting, dancing, and pop-music.

Name: George Pampoe

Address: Mfautsipium School, P.O. Box 101, Cape-Coast, Ghana, West Africa. **Age:** 13

Hobbies: Photography, karate, music.

Name: Benjamin Enu-Kwesi

Address: Kwame Nkrumah Secondary School, P.O. Box 77, Axim, Ghana, West Africa. **Age:** 18

Hobbies: African art, travelling.

Name: Kalarani Kanapathy (girl)

Address: 166C Back Lane, Sungei Siput (N), Perak, Malaysia. **Age:** 16

Hobbies: Pop songs, reading, gardening and hiking.

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LOOK AND LEARN

No.870, 16 SEPT, 1978.
IPC MAGAZINES LTD.,
KING'S REACH TOWER,
STAMFORD STREET,
LONDON SE1 9LS.
Telephone: 01-261 5000

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The Clue To A Fifty Million Year Mystery

The discovery of a fossil of a prehistoric dragonfly has given geologists and naturalists a key to the mystery of insect flight

GEOLOGISTS studying fossils deep in the Earth's surface made an important discovery. In the layers of a flint-like quartz in Scotland was a fossil of the earliest-known insect. This is a wingless springtail which was on Earth some 350 million years ago.

Later, in a coal-mine at Bolsover in Derbyshire, geologists found a 300 million year old fossil of a dragonfly.

Between the two — the earthbound springtail and the flying dragonfly — lie 50 million years of mystery. Somewhere during this time, insects learnt to fly. But how and why they did this is not known, for the fossil record does not tell us. We can only make conjectures based upon the facts we possess.

It has been suggested that wings did not have their origin in the need for an insect to fly but to obtain warmth. Veins, through which blood circulates, form a tracery in an insect's wings. Often these serve as a means of conveying the sun's warmth to the rest of an insect's body.

Originally, there could have been thin flaps distributed all over the body. So that they could have been turned towards the sun, they would have needed muscles. This, it is conjectured, could have been one of the ways in which movable wings with muscles came into being.

This intriguing theory is but a conjecture, for although we know a great deal about the structure of the insects some 300 million years ago, our knowledge of their origins and the evolution of their wings is very inadequate.

Geologists were, therefore, delighted by the discovery of the Bolsover dragonfly. It showed them that the dragonflies of prehis-

toric times were enormous and had large wingspans. The Bolsover dragonfly, which was 600 m. deep in the coal, had a wingspan estimated at 200 mm. It is one of the oldest known flying creatures. It was winging its way through the air 100 million years before those terrifying flying reptiles, the pterodactyls, and 150 million years before the birds arrived.

Swarming Forests

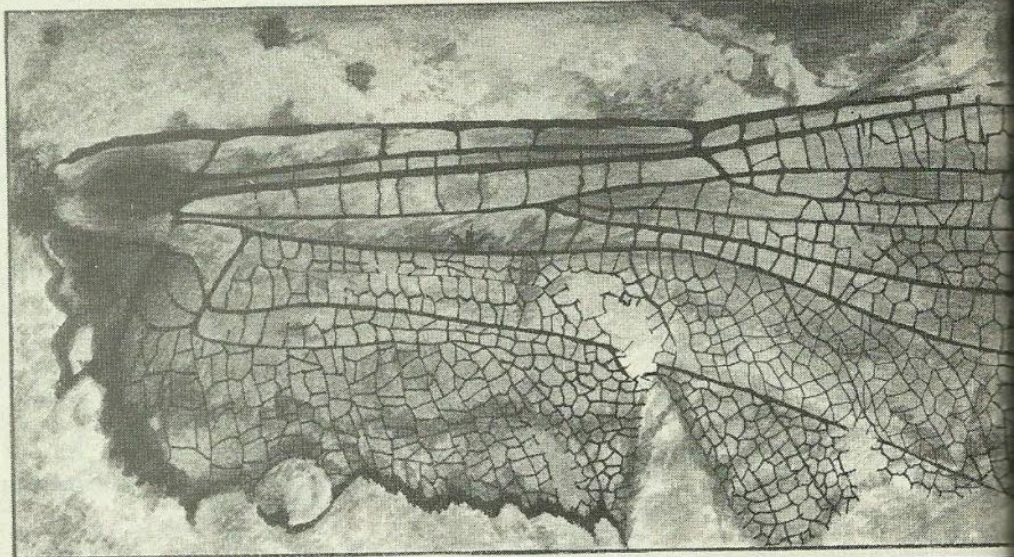
No dragonfly living anywhere in the world is as large as this early creature was. Its fossil is not complete and consists of only

one wing. But this is sufficient to enable a picture of the creature to be constructed. It contains considerable detail and shows a tracery of fine veins running between the main veins.

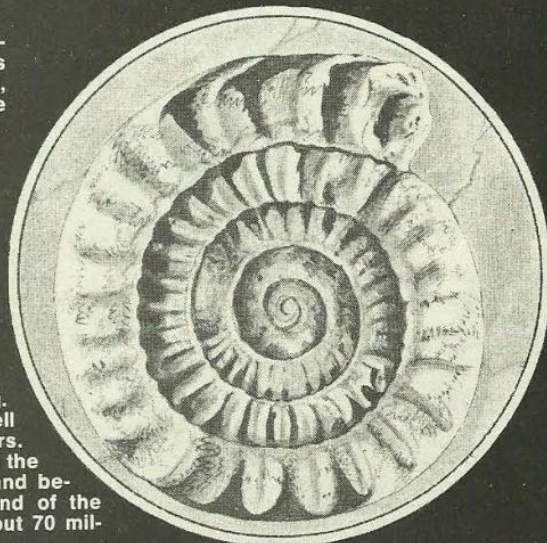
The period during which this dragonfly was living is known as the Upper Carboniferous. Eleven major groups of insects were alive then. The fossil record shows that some of them had complicated patterns on their wings, including eye spots like those seen today on the peacock butterfly.

Judging by the fossils that have been found, the forests were swarming with insects. In addition to the dragonflies, there

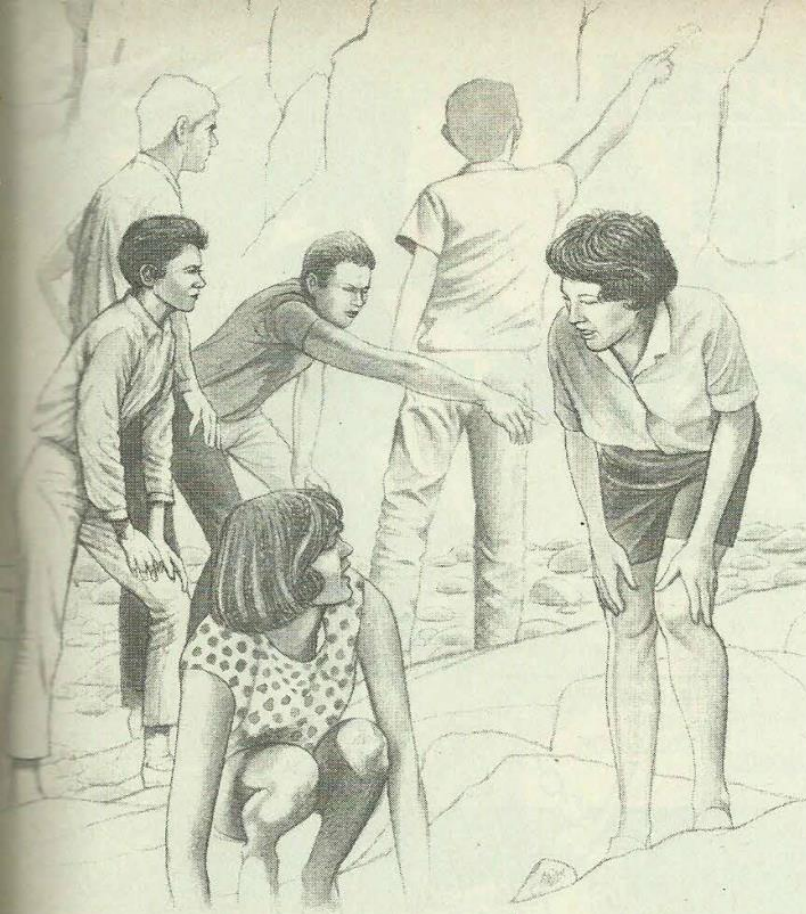
A 300 million year old fossil of a dragonfly was found in a coal-mine in Derbyshire.



Ferns like those on the left contributed to the formation of coal beds in the Carboniferous period, which is also known as the Age of Ferns.



Ammonites (right) were molluscs. They were members of the class of cephaloda to which cuttle-fish belong. Each had a coiled shell divided into chambers. Ammonites appeared in the Carboniferous period and became extinct at the end of the Cretaceous period, about 70 million years ago.



JANET BLAKELY

THE GEOLOGICAL ERAS

Million years ago

PALEOZOIC	Quaternary (Primates)	1.5
	Tertiary (Mammals)	65
MEZOZOIC	Cretaceous (Rise of mammals)	136
	Jurassic (Birds)	195
	Triassic (Rise of dinosaurs)	225
CENOZOIC	Permian (Reptiles)	280
	Carboniferous (Insects)	345
	Devonian (Amphibians)	395
	Silurian (First amphibians)	440
	Ordovician (First fish)	500
	Cambrians (Crustaceans)	570
CRYPTOZOIC	Pre-Cambrian (Primitive life)	4550

were mayflies, cockroaches and many others, big and little. Some had strong jaws for eating and others had long suckers to draw the fluid from plants in the manner of the present-day greenfly.

Evidence for this is provided by plant fossils which reveal damage such as could have been caused by an insect's sucker tube. There could even have been predatory insects which sucked fluid from the body of their prey.

Flying insects are in two groups: those which are unable to fold their wings completely when at rest — like modern dragonflies — and those which can. Both of these were in existence in the Upper Carboniferous times when an insect's ability to fold its wings could have affected its chances of survival. Insects with folded wings can,

once they have landed, move easily through the thick undergrowth. But an insect with its wings held at right angles to its body would soon have fallen prey to one of the early land vertebrates.

A very important part has been played by the insects in the story of evolution. They have provided food for other animals, transmitted plant disease and helped in the cross-fertilisation of plants by carrying pollen from one species to another.

Insect fossils are often considered to be rare. But this is not really so, for there are deposits in which they have turned up in their thousands. American and Russian scientists have studied great numbers of them. And in Britain, fragments of insects have been found in the Lower Cretaceous layer formed about 120 million years ago.

From a study of these it has been deduced that insects evolved from an air-breathing ancestor that was a like a modern millipede. Bristletails and twintails developed from this ancestor, and from them came the winged insects such as the dragonflies and mayflies.

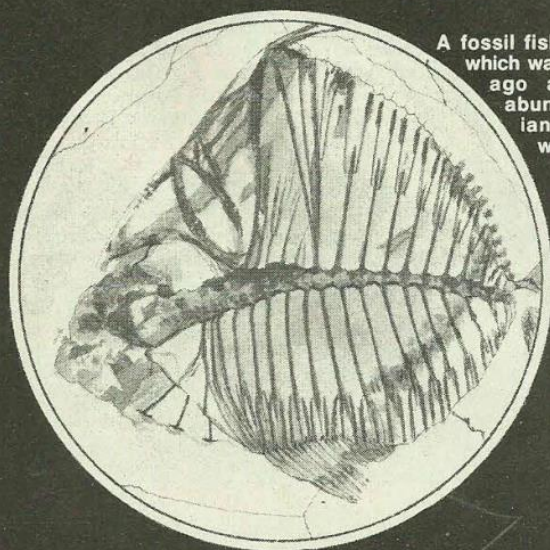
At the beginning, the method by which an insect passes from its larval stage to adulthood — known as metamorphosis — was incomplete. In the earliest times, the adults were similar to the young. But, for many kinds of insects, eventually metamorphosis took on a complete form and produced adults that bore no resemblance to their young. Thus, the young grub could pass through a chrysalis phase and emerge as a flying insect.

Insects have a tremendous ability for survival. They have withstood changes of climate and the shifting continents. They abound in the most arid of deserts. Some live on the surface of the sea far beyond the sight of land. And others live and breed in the snows of the Himalayan peaks.

Some idea of their amazing power of survival may be gained from the fact that species have been discovered frozen solid at 30 degrees below zero Centigrade and still living. At other extremes are insects that live in the hot springs of Iceland and New Zealand in which the temperature is more than 50 degrees Centigrade — and that is half as hot as boiling water.

But it is the insects' fantastically big families that ensure their survival despite their host of enemies. The females of some species lay millions of eggs every year.

With this fact comes a frightening thought. If huge proportions of these were not destroyed before they were hatched, and if insects did not prey on each other, they would increase in number very rapidly. In a few years, they would literally cover the Earth.



A fossil fish skeleton of the Tertiary epoch which was between 20 and 70 million years' ago approximately. Fishes became abundant during the Silurian, Devonian and Carboniferous periods. They were especially numerous in the Devonian period which has been called the age of fishes.

SPACE The Final Frontier

Beyond the year 2000, the challenge of creating his own new worlds will lure man up into space and across the solar system

THE precious moon ores are loaded aboard the spaceship. With a roar, it rises on a cone of flame from the grey planet and heads into the vast void. Its destination lies thousands of kilometres away — a space station spinning slowly on its own axis like a huge Catherine wheel where scientists wait to process the lunar minerals before sending them to Earth.

Nearly two kilometres across, the space station encloses a man-made world with homes, laboratories, farms, and even lakes and rivers.

A tableau from a space fantasy film? No. This is really how the scientists of today foresee the space worlds of tomorrow. Within the next 20 years, they predict, man will set up a moon base.

Thousands of people will leave this teeming world with its rising population and colonise huge space stations. Like the questing pioneers of old who sailed off across uncharted oceans, they will be carried aloft in spaceships into the unknown heavens and send back to Earth new sources of power and minerals.

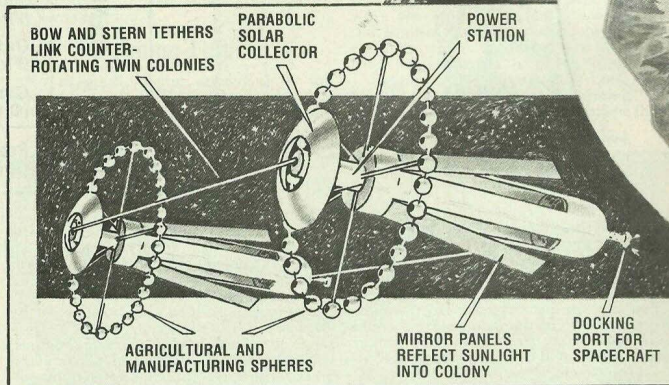
Professor Gerald K. O'Neill, of Princeton University, who heads a group of physicists designing solar satellites, has estimated that a space colony accommodating 10,000 people could be built by 2025. He was among some 30 scientists who met two years ago to study the industrialisation of space.

Their amazing conclusion was that a 500,000-ton wheel-shaped habitat over a mile (1.6km) in diameter could be built somewhere along the moon's orbit. The wheel would rotate around its hub at one revolution a minute — fast enough for the centrifugal force on the inhabitants to simulate their weight on Earth.

On the rim of the space station would be accommodation for 10,000 people, with shops, schools, hospitals, light industry, farms and an earth-like environment and atmosphere. Interior views up to half a mile away would be created, embracing scenes of trees, flowers and rivers. Heavy industry would be carried out outside the station, making use of the weightlessness and high vacuum of space.

According to the space scientists, the principal industries would be the processing of moon materials and the manufacture of other space stations and solar satellites to be put in orbit around the Earth. Workers would be buzzed from the station to their "work sites" in small spaceships.

America's Apollo moonshots of the last



Space colonies orbiting the moon, 25 kilometres long and 6 kilometres in diameter, would be tethered in pairs. To maintain their positions in space, they would rotate in opposite directions, the spin also providing gravity for the inhabitants.

decade revealed that lunar materials contain from 20 to 30 per cent metals, 20 per cent silicon and considerable amounts of oxygen. About 150 people on the moon could mine about one million tons of these ores each year and ship them to the space station. There they would be refined to extract aluminium and, perhaps, titanium for building materials, silica for glass and oxygen for hospitals, rocket fuel and other purposes.

Intensive Farming

There would also be intensive farming in the space station because grains and certain other plants grow faster with the more light they receive. A space farm could be provided with up to 24 hours a day sunlight and the concentration of carbon dioxide and water vapour would be adjusted to produce greater yields.

Vegetables, cereals, poultry, ham and dairy products for a population of, say, 10,000 people could be grown on an area of about 111 acres, which would also support rabbits and 2,800 head of cattle.

Eventually, according to Professor O'Neill and his colleagues, the asteroids themselves would be exploited for the ele-

ments of carbon, nitrogen and hydrogen which are scarce on the moon but vital for human life.

A typical asteroid is a lump of rock about 40 kilometres across: there are thousands of them in the solar system. With the elements they contain, space scientists claim that colonies could be built with a total land area 3,000 times that of Earth. Eventually the size of individual colonies could be extremely large — huge spherical stations with 20-kilometre diameters, containing a land area of 650 square kilometres.

As with most plans on Earth, it will also be very expensive. The total cost of the first colony including all the development work is estimated at £50,000 million, over twice the outlay on the Apollo flights.

Nevertheless, the American scientific team remain optimistic. Their report summed up the future like this. "Space colonisation may offer a way to bring new wealth to the Earth and new opportunities to its people, without the environmental damage which has so often accompanied growth in the past."

NEXT WEEK: When The Tide Comes In: harnessing the energy of the sea.

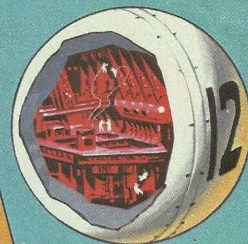
WILF HARDY



Each colony would have its own atmosphere, with sunlight reflected in by giant mirrors. Real "weather", day and night, and seasons would be possible with full control of the elements.

Only two per cent of the colony's building materials would come from Earth. The rest would be mined on the moon and shot up into orbit by solar-powered electromagnetic launchers.

Manufacturing spheres would be made to split apart to release completed machinery modules. Each independent sphere would be a specialised unit for animals, crops, metalwork or chemicals.



INTO THE UNKNOWN

The Explorers No One Wanted

Hounded from state to state for their religious practices, the Mormons finally decided to leave settled American territory and trek into the unexplored Rocky Mountains to find a homeland of their own

"MY advice to you is to get off by yourselves where you can still enjoy peace. In fact, I reckon if you don't leave at once the Federal Government might not let you leave at all, because they may think you'll join up with the British and try to take the West from the United States . . ."

The speaker was Governor Thomas Ford of Illinois and the big, bearded man he was addressing across his large wooden desk was Brigham Young, President of the Church of Latter Day Saints. The one thing that Governor Ford wanted more than anything else in that winter of 1845 was Brigham Young and his followers out of his state—as far away from the State of Illinois as he could persuade them to go.

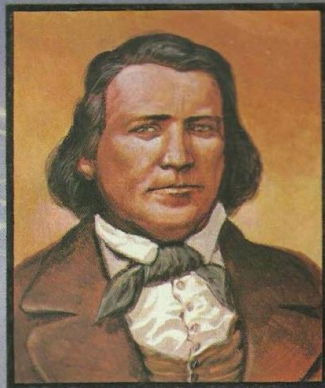
The Mormons, or "Saints" as Brigham Young's religious followers sometimes called themselves, had never been the most popular of people wherever they had settled in their short career. One reason was

their doctrine of plural marriage — the Mormons had decided they could have more than one wife if they wanted to — an idea that greatly upset conservative 19th century Americans. President Brigham Young, indeed, himself chalked up an impressive total of 27 wives.

Nor did many Americans think very much of the way in which Mormonism was founded as a religion. Its first prophet was Joseph Smith, who had a vision when he was a 17-year-old farmer's son. Smith claimed that he had been visited by one Moroni, a messenger from God.

Moroni told Smith that under a rock on a hill near his home in New York State he would find a stone box containing some translating spectacles called the Urim and Thummim and some plates with hieroglyphics on them. Using the Urim and Thummim, Smith made a translation of the plates and wrote the Book of Mormon, upon which his new religion was founded.

Even when starving to death in the depths of a Rocky Mountain winter, the Mormon pioneers would not eat meat stored in a nearby shed because their religion declared it unclean. They overcame all temptation by breaking the ice in a river and hurling the meat into the swirling water.



Brigham Young

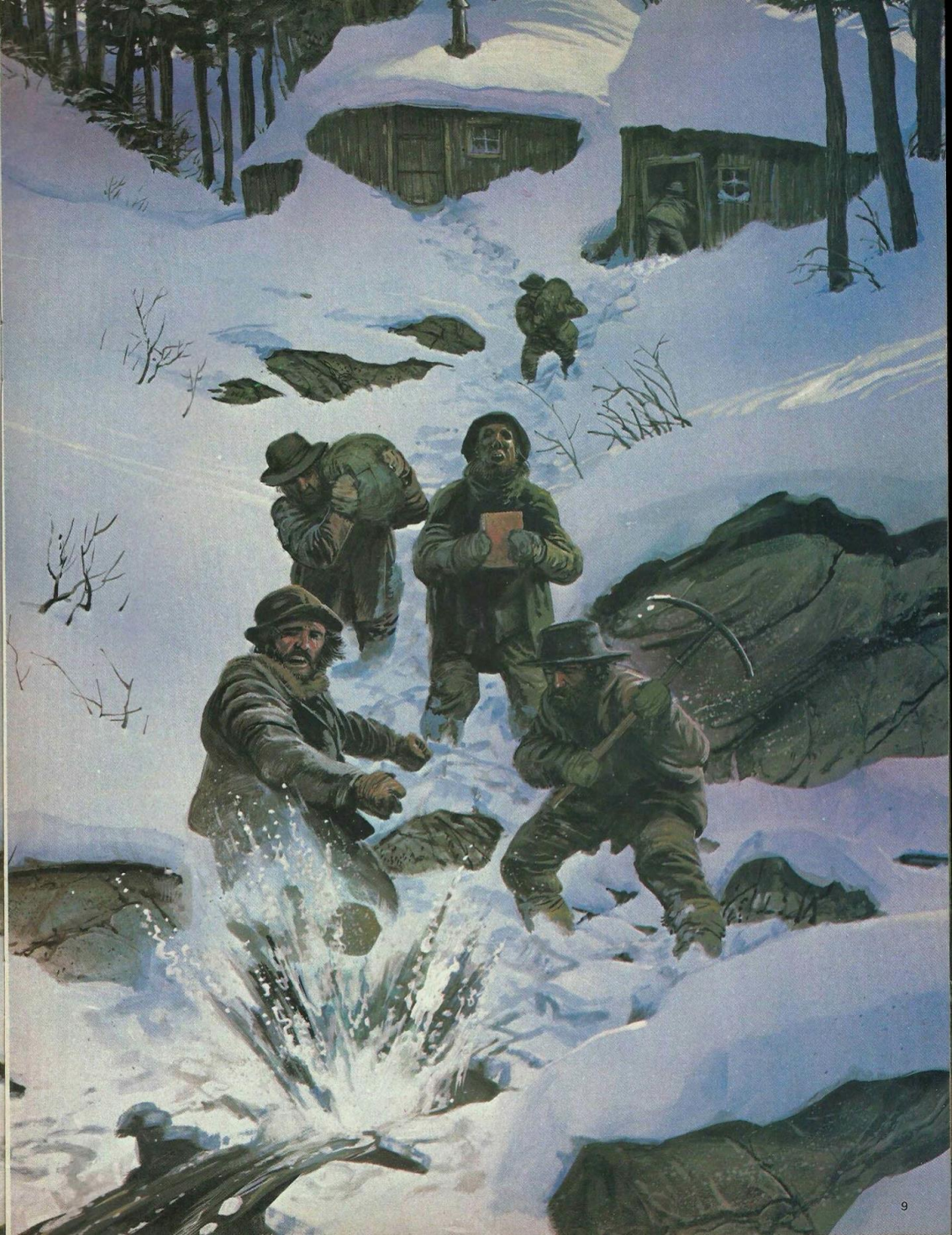
OLIVER FREY

Surprisingly, considering such unlikely beginnings, Smith won himself many converts and Mormonism took root. Some deeply religious Americans liked particularly that part of its teaching that resited certain Biblical events, including the story of the Garden of Eden, on the soil of America.

Others, particularly those in Ohio, where Smith led his followers, noted that the Mormon leader was wild, dishonest and often drunk, with apparently much more of Satan in him than God. They thought the Book of Mormon was like a popular version of the New Testament and someone even suggested it was like the plot of a novel written by a local vicar, the manuscript of which had mysteriously disappeared at the time when Smith began his translation.

There were more enemies of Mormonism than friends, and Smith was attacked and tarred and feathered. Hastily, he moved his flock, first to Missouri, then on to Illinois,

CONTINUED ON NEXT PAGE ►



where, a year later, he was gunned down by an hysterical lynch mob. It was then that Brigham Young, a house-decorator and carpenter, became the second President of the burgeoning tribe of Mormons.

And it was then that Governor Ford made it clear to Brigham Young that the Saints were not wanted in his state and that everyone in Illinois would be happier when they had gone.

It was November, 1845. "We shall go as soon as the grass grows and the water runs," Young told his unfriendly neighbours. But to understand the dilemma he faced, we must realise that in the middle of the 19th century much of America was still unexplored and still more of it was uninhabited by white men. Across thousands of miles of unknown territory there were hostile Indians, extremes of weather, mountains, deserts — a host of perils for the explorer.

Brigham Young was nonetheless determined to stick to his word. Four months later, he had 3,255 families organised for the move in no less than 1,500 wagons. Full of faith and hope, they set off west — to the Rocky Mountains and a new way of life that lay beyond.

Terrible Losses

By the late spring of 1846 they reached the Missouri River, but they had paid a terrible price. Men and animals died in droves from hunger, sickness and physical exhaustion. Many had no previous experience of anything but town living and the pioneer hardships they had to face were made even worse by their lack of essential outdoor skills.

Yet every day at least one new Mormon child was born on that incredible journey. While the rain lashed the tents and wagons and snow blizzards enveloped the landscape, the first cry of a new infant would bring smiles of gladness to the bone-weary travellers. A woman who chronicled the journey wrote:

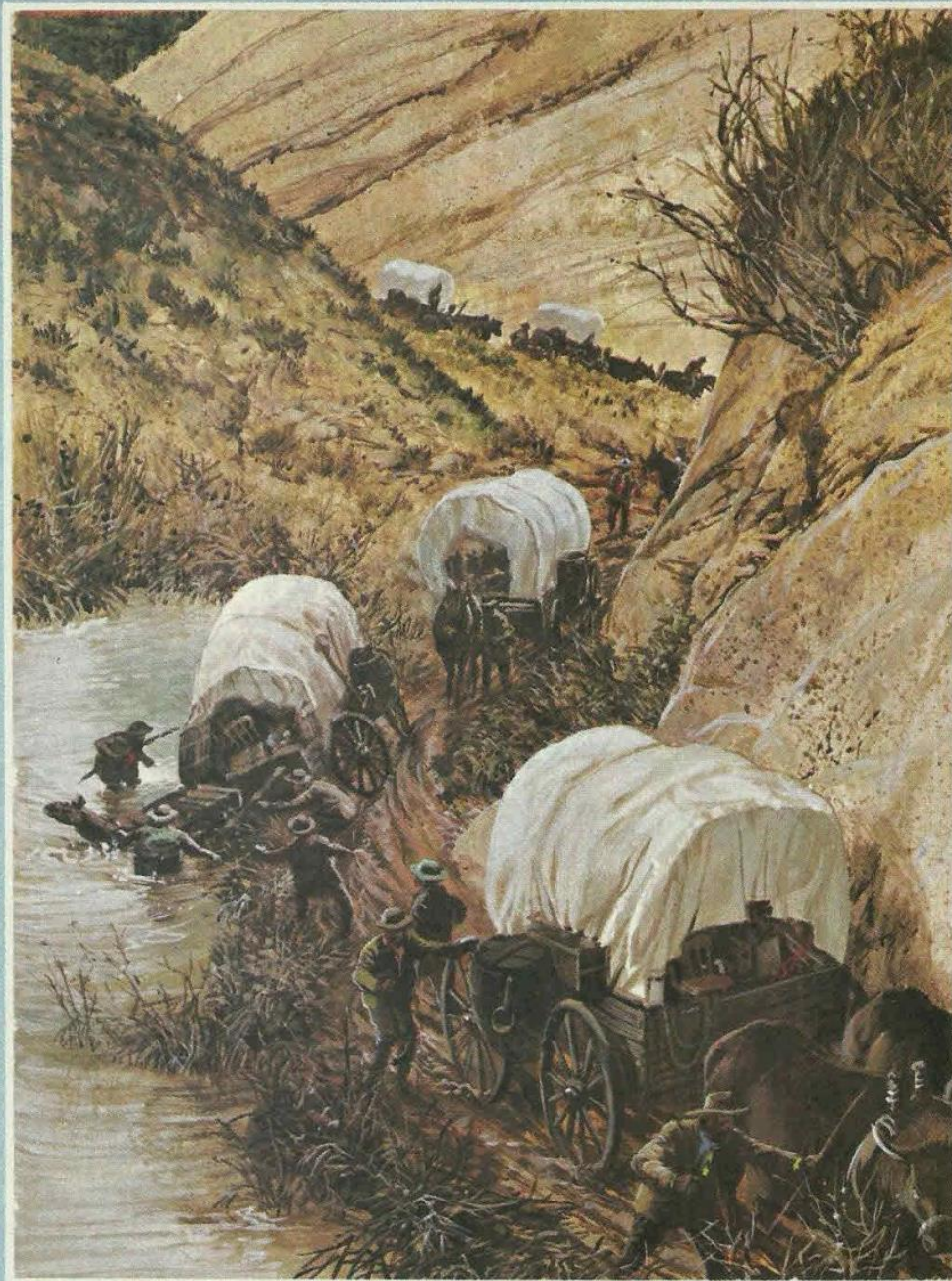
"I heard of one birth that occurred under the rude shelter of a hut, the sides of which were formed of blankets fastened to poles stuck in the ground, with a bark roof through which the rain was dripping. Kind sisters stood holding dishes to catch the water as it fell, thus protecting the newcomer and its mother from a shower-bath."

Behind Brigham Young's huge convoy came 17,000 more Mormons in a continuous trek that went on for seven months. They set up winter quarters at Florence, Nebraska, and braved the perils of a terrible winter. Through it all Young ruled his flock with an iron fist, maintaining firm discipline in a situation where order could quickly have turned to chaos. Three youths caught flirting, for instance, were tried, convicted and flogged.

During the terrible journey one Mormon, Daniel Jones, was snowbound for months with his companions in a rough hut, slowly starving to death. In a nearby shed was enough meat, deep frozen in the biting cold, to feed them all bountifully.

Every day Jones and his friends thought longingly of that food, but they refused to touch it because it was "unclean" according to Mormon laws. Eventually, unable to stand the strain any longer, the Mormons broke the ice in a nearby river and hurled the meat into the swirling black water — thus overcoming all further temptation.

During the next few weeks the men survived by eating their moccasins, the hide



In covered wagons, on horseback, and even on foot, thousands of settlers travelled the Mormon Trail over the mountains to Salt Lake City, their chosen home.

tyres of cart wheels, a doormat and an old set of harness. They even turned a mule saddle into stew.

Meantime, Brigham Young had had another revelation: he was told that he would find a settlement for his people in the Rocky Mountains. The vision drove the prophet on through a scorching summer into mountains where no white man had ever been before.

Here they were slowed down by having to make tracks and by a mysterious mountain sickness that brought on blinding headaches, fever and agonising pains in the back and in the joints of arms and legs. It was caused, Young wrote later, by "the cold frosty nights of the mountain pass, followed by warm days and the great dust of the succeeding plains."

In the mountains the Mormons chanced upon Jim Bridger the legendary scout and trail-blazer. Bridger was an old man then, wise in the ways of the West and, shaking his head in disbelief, he warned the Mormons to go back, for the way ahead was more barren than anything he had seen.

For answer, Brigham Young pressed on. He had decided to settle his followers in the desolate and infertile Salt Lake Basin — a place which, according to American government surveyors who had studied it, was uninhabitable.

Young, weak with mountain fever, sent a scouting party ahead to pitch camp in the great valley of the Salt Lake Basin. The men struck the ground with a plough and found it so hard that the ploughshare broke off. To sow the first crops they had to divert a stream in order to soften the ground.

Brigham Young entered the valley in a covered wagon and gazed enraptured at the desolate wilderness that was his people's promised land. He had travelled more than a thousand miles to attain it and behind him tens of thousands were following in his footsteps along what became known as the Mormon Trail.

Today upon that wilderness is built the great Salt Lake City — the "City of the Saints", State capital of Utah and headquarters of the Mormon Church, whose followers are spread worldwide.



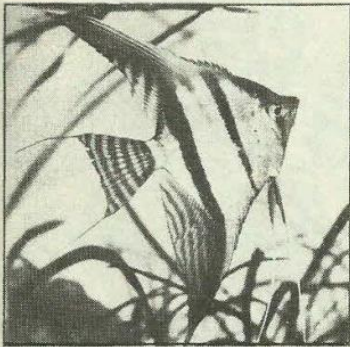
ANSWERS PLEASE!

A WEEKLY PAGE TO TEST YOUR WITS

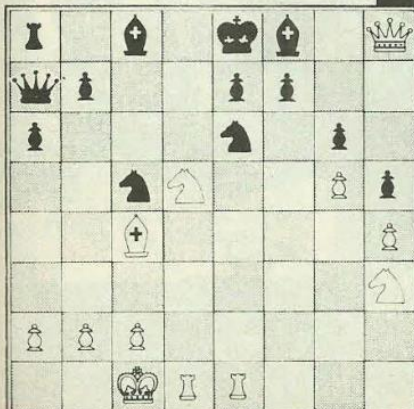
Ask Me Another

How many of these general knowledge questions can you answer?

1. What are the names of the two Britons who so narrowly failed to become the first men to cross the Atlantic by balloon?
2. In which country is the city of Accra?
3. What type of fish is pictured above?
4. Who is the Prime Minister of the Republic of Cuba?
5. Who had a famous horse called Black Bess?
6. Which monarch had the shortest reign in British history?
7. What is the metatarsus?
8. In which of the following years was the Suez canal opened — 1860, 1869 or 1872?
9. Which famous fictional character had a butler called Jeeves?
10. What type of tool is a jemmy?
11. What type of person is called a 'quack'?
12. From what ingredients is marzipan made?
13. After which American president was the 'Teddy' bear named?
14. Who was the Roman god of war?
15. In which Canadian city did the recent Commonwealth games take place?
16. What is a sinecure?



17. To which political party does the man pictured above belong?
18. What are samoyeds?



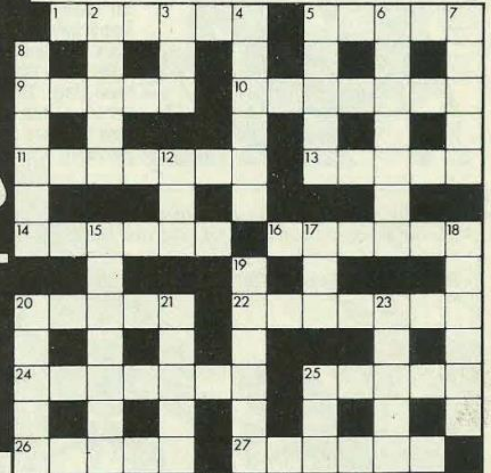
YOUR MOVE

Our weekly challenge to chess players

In this position, White announced checkmate in four moves. How did he win?

ALL THE ANSWERS ARE ON PAGE 27

THIS WEEK'S CROSSWORD



ACROSS

1. A signed agreement between countries (6).
5. They are defenders in a football team (5).
9. A person who is in direct competition with you (5).
10. A short length of cord for securing a whistle or knife (7).
11. Province of Canada (7).
13. She is mythically connected with Troy (5).
14. Ball game played with curved sticks of wood (6).
16. Banquets or religious anniversaries (6).
20. Fret (5).
22. Missions (7).
24. French girl's name (7).
25. Triangular-shaped glass which refracts light (5).
26. Intensely disliked (5).
27. To walk unsteadily (6).

DOWN

2. Bolt used for fastening metal plates together (5).
3. Suffer illness (3).
4. One of the primary colours (6).
5. You may pick flowers and form them into one (5).
6. Babies sleep in them (7).
7. A Biblical town usually associated with Tyre (5).
8. Ornament usually pinned on to clothing (6).
12. Egg mass in fish (3).
15. Accurate (7).
17. Make a mistake (3).
18. East Indian herbaceous plant (6).
19. Feel indignation at (6).
20. You may wear it on your wrist (5).
21. Give way (5).
23. Unpleasant sound (5).
25. It probably yields coal (3).

Familiar Place...

but where?



Familiar Face...

but whose?

Face To Face With A Mountain Giant

Tense moments follow when a bear, confronted by a man with a gun, rears up. How will the encounter end?

BEARS are usually as afraid of people as people are of bears. But to every rule there is an exception. And when a bear which has strayed into a hunter's camp rears up and stands its ground against the man and his rifle, the moments that follow are tense. Will the bear attack the man? There have been reports of a bear being hit by large bullets from wide-bore rifles and still pressing home a deadly attack on the hunter.

For a moment, the man stands poised with his gun, waiting for the bear to decide that he offers no danger. Then the tension is over. The man sighs with relief as the bear drops on to all fours and ambles away.

Probably, the danger was less than he feared. Bears do not usually attack while reared up on their hind legs. Most attacks are made with the animal on all four legs. And it is more likely to bite its opponent than to claw him.

Nevertheless, when the Alaskan Brown Bear rears up to its full height, it looks like a furry mountain before the puny man with his gun. It is of immense size and can weigh almost a ton and be nearly four metres in length.

Great Size

Alaskan Brown Bears are confined almost exclusively to the coast region, ranging from the Bering Sea throughout the Alaskan peninsula and some outlying islands, and thence along the Pacific coast to the Alexander Archipelago.

Their colour varies greatly, ranging from dark seal-brown to buff-brown. The ends of the hair are often paler than the bases. But they are not silver-tipped like the hairs of grizzly bears. The front claws are thicker, shorter and noticeably more curved than in the grizzlies.

Owing to their great size, brown bears are doubtless more powerful than grizzlies, but they have the reputation of being more peaceable. As a rule, like many other wild animals, they give man a wide berth. But in close quarters or in unusual circumstances they have been known to injure or even kill human beings.

Like most other bears, these huge creatures eat everything that the country provides in the way of food, including fish, flesh, fruit, roots and grass.

After spending the winter sleeping, the bears emerge in the spring and exist on a

diet of young grass, herbage and roots. If they live near the coast they may also eat a little kelp (seaweed).

Later they capture mice and ground squirrels and when midsummer and the salmon come they make fishing their chief business.

In the summer, the Alaskan rivers are almost choked with millions of hump-backed Pacific salmon which die soon after spawning. The brown bears subsist almost entirely upon these for several weeks. In the autumn they fatten on berries.

Extinction Threat

Early this century, it was feared that the Alaskan brown bears would become extinct within a few years. "Already they have become scarce on Kodiak Island, where they were formerly very abundant. On the Alaskan peninsula, though still fairly numerous, they are being killed probably at a rate greatly in excess of their increase," a naturalist reported.

However, the situation did not become as serious as the early writer feared. In recent years, a naturalist camping on Kodiak island "encountered, tracked or otherwise observed" 22 Kodiak bears. One of them, an old chocolate bear, left a paw print 380 mm across.

Other members of the bear family are found in many parts of Europe and Asia, and in America and Africa. In Africa they live only in the Atlas mountains and in South America they are restricted to the Andes. They were formerly found in Britain, but seem to have become extinct in the 9th century. The brown bear is found in most parts of Europe and ranges into Siberia.

America has several species of bear, the most familiar of which are the grizzly and the black bear. The grizzly is a meat-eater and is very dangerous to man. This animal is certainly the king of the North American wilds. Even the powerful mountain lion and the timber wolf withdraw when the grizzly comes to feed.

Over the years, bears have learned that where there are people there is food. And that could be why a bear rummages among a camper's pots and pans. Unfortunately, if a person gets in the way or a bear feels trapped or frightened it could rear up. And that is when the trouble begins for the hapless camper.



WINGS ACROSS THE WORLD

Faster, Farther- And Cheaper

With the advent of the jet-propelled airliner, flying ceased to be the prerogative of the rich
You can read Part 7 of our exciting series on page 18



The Moslem pilgrims of the Middle East who wish to fly to the centre of their religion at Mecca are not concerned with luxurious travel. Their only requirement is that they reach their destination as quickly and cheaply as possible, for which purpose the Douglas DC-10 (shown here) is ideally suited.



SLOWLY, the colossal hangar doors slid open and the September sunlight shone upon a mammoth of the flying world. "Roll her out boys," cried a voice. Dramatically, the first Boeing 747 to be completed made its silent and majestic debut.

It was an enormous plane, capable of carrying 490 passengers at a cruising speed of 624 mph and it ushered in a new era in air travel. With its appearance at Everett, Washington, USA, the age of the giant jet had begun.

However, this event in 1968 had been preceded by an even earlier landmark in the history of jet aircraft. This had occurred in 1952 with the arrival of Britain's De Havilland Comet, which was the world's first jet airliner.

Two years after they first entered service, two Comet 1s exploded in mid-air. By the time the more advanced Comet 4 appeared, the Russians had stepped in with their noisy but successful Tu 104.

Although these early jets were expensive and carried relatively few passengers, they were the first of a new breed of airliners destined to make air travel cheaper.

Soon, a whole family of Boeings were arriving from America. Starting with the long-range 707, they were followed by the smaller 727 and 737 and by the giant-sized jumbo jet, the 747. France produced its beautiful Caravelle and Britain its Trident and BAC 111. Many of these planes were

subsequently modified to increase their passenger-carrying capacity.

People proved willing to put up with less leg room, baggage space and food during flights, preferring, instead, cheap and fast travel. This was available on the specially adapted Comet 4B which found a place in the package tour market.

The age of luxury was gone. If some airline operators were taken by surprise by this turn of events, others were not. Airlines in the Middle East had for long been flying thousands of Moslem pilgrims to their holy city of Mecca each year. These pilgrims were not over-concerned about comfort. They simply wanted to reach the centre of their religion.

Holiday Boom

Pilgrims still fly to Mecca. As their numbers are ever increasing, it is not surprising that airlines like that of Saudi Arabia, with its great Lockheed Tristars, and Pakistan International Airlines, with their green and white Douglas DC-10s, insist on big aircraft.

Few Europeans are willing to endure discomforts like those borne by the Moslem pilgrims. But tourists on their way to the holiday places in the Mediterranean area seem willing to put up with some crowding for the sake of a cheap holiday. Package tours are the bread and butter of many airlines and the people who take part in them are the flying millions of our air age.

The cost of flying had started to come down with the introduction of economy fares in 1958. Before this occurred, only the wealthy could afford to travel by air. The year of 1958 was also a special one in the story of passenger aviation for two other reasons. It was the year in which jet airliners came into general operation and one in which the numbers of passengers who flew the Atlantic became greater than those who went by sea. Nevertheless, it was still costly to fly from Britain to Europe.

But as the years passed by, air fares became lower, reaching a new level of cheapness in September, 1977, when the Skytrain was started by a British businessman. For this, passengers went to the airport and boarded the aircraft without making a previous booking.

Alongside the development of the big jets, there has grown a demand for smaller planes for shuttle services like those which link Belfast, Glasgow and Edinburgh with London. As commuting by, for instance car or bus becomes more time-consuming, Britain's internal flights are likely to become increasingly popular. In America, scheduled air taxi operators are an everyday feature of air transport.

The years ahead are full of promise for manufacturers, airlines and passengers. Faster planes, lower fares, helicopters linking airports . . . these are just a few of the things that may appear on the flying scene of the future.

The Comet 4B (shown here in Dan Air livery) was one of the first high-density passenger transports and a pioneer of the package tour industry.



The Village That Sacrificed Itself

THE village of Eyam, pronounced "Eem", is remote, even today. Visitors to the Derbyshire Dale country who drive between the typical local drystone walls from Little Hucklow to Great Hucklow, and then on to Grindlow and Foolow, will eventually come to Eyam. There they will find a small village green, which still boasts a pair of rather time-worn stocks, a relic of the days when anyone who misbehaved himself could expect to be imprisoned in them until he had seen the error of his ways.

Further on there is one of the few sheep-roasting spits left in England, a good deal smaller than the traditional apparatus for ox-roasting, but in these days of expensive meat, a good deal more practical. The local building is of stone, typical of the countryside, and the village is well worth a tourist's snapshot for its appearance alone.

However, this is not just another village in the Peak District, this is the "Plague Village", remembered for 300 years for the steadfast bravery of its people. No special monument commemorates the fact, because the village of Eyam is its own memorial.

London Smitten

In 1665, London was in the grip of bubonic plague, the Great Plague that was to claim more than 65,000 victims in the city before it was done. Plague was not new to London, for there had been odd outbreaks for hundreds of years, as indeed there had been in most parts of Europe. People accepted it as something that came from the East, spread mysteriously, and just as mysteriously went away again.

How it was passed from one person to another they had no idea; certainly nobody knew of a cure. When there was an occasional outbreak one simply hoped for the best, and if the disease looked as though it might be taking hold, anyone who could afford to, fled.

There were a few cases of plague in Westminster during the autumn of 1664, but no more than usual. But in the spring the following year, it crept down Holborn and within six months had travelled from one side of the city to the other. Forty-three people died of plague in May, 1665; 590 in June; 6,137 in July and 17,036 in August.

The summer was an unusually hot one, and the disease bred rapidly in the filthy, tight-packed streets. Even today we have no means of knowing what

When a box of infected clothing brought the Plague to the Derbyshire village of Eyam, the inhabitants voluntarily isolated themselves from the surrounding districts — but at a terrible cost to themselves

caused this particular outbreak, but it seems likely that it was introduced by some Dutch prisoners of war, and then spread by the fleas of the black rat. But once plague broke out in a city, all it needed to spread like a forest fire was heat and dirt, and in 1665 London had an abundance of both.

Two thirds of London's 400,000 inhabitants left the doomed city as quickly as possible. The King and his court went to Oxford, the less well-connected to anywhere that could provide them with a temporary home. In many cases the refugees took the dreaded illness with them, while London literally took on the appearance of a city of the dead. Those who stayed behind were mainly the poor, who had nowhere else to go, and a small number of officials who considered it their duty to stay.

Among the latter was the diarist, Samuel Pepys, who could easily have found an excuse to move with the court, but as a civilian naval official, he felt that to stay at his post was the equivalent of showing cour-

age in battle. He was also driven by an overpowering curiosity that was stronger than fear, and to which we owe his wonderful on-the-spot descriptions of a London where grass grew in the streets and there were not enough fit people left to bury the dead.

Eyam, in far away Derbyshire, was sufficiently remote not to be troubled with refugees, but even so, it was still within reach of the plague. In the late summer of 1665, a London tailor despatched a parcel of clothing to a client who lived in the village. Some of the clothing was second hand, and, like even the costliest of clothing at that time, it carried fleas. By October, no less than 25 of the people of Eyam had died of plague.

The man who took charge of the situation was the rector of Eyam, the Reverend Peter Mompesson. A man of great personal courage, sufficiently educated to realise what the outbreak could mean to the still healthy areas around him, Mompesson summoned the villagers and outlined his plan.

Eyam was in the grip of plague, but there was no reason why they should involve others in their misfortune. Mompesson suggested not only that no inhabitant of Eyam should move beyond the village boundaries, but that no outsider should be allowed in.

It was a harsh rule, but it made sense, and because they respected their Rector the people of Eyam agreed. So stones were erected in a rough circle around Eyam in order to mark the limits of the Derbyshire village. Essential provisions, such as flour and salt, were brought from neighbouring hamlets and left on certain specially-designated stones. These were paid for in money left alongside in troughs kept filled with vinegar in the belief that this would free the coins from infection.

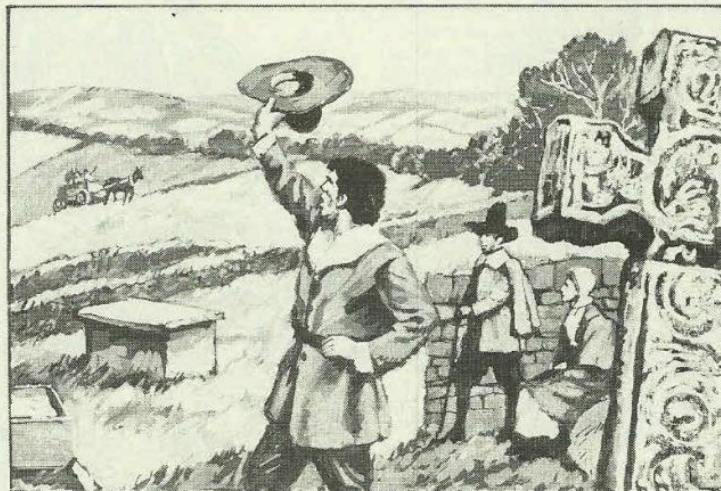
Mompesson also gave orders that the people of Eyam, men, women, and children, should smoke as much tobacco as possible, because this was widely believed to be a safeguard against plague.

Deadly Toll

It does not seem to have been a very efficient solution. Ten months after Eyam commenced its voluntary isolation, seventy of its inhabitants had died. Sunday by Sunday, the Rector gathered a steadily-dwindling congregation on a small, horseshoe-shaped curve of turf and small trees just inside the village circle known as Cucklet Dell, and there in the clean, fresh air he did what he could to strengthen their faith and courage.

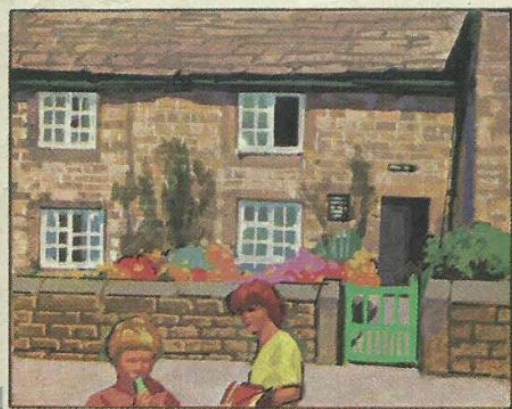
Courage they certainly needed, for by the end of the year 259 villagers had fallen victim to the plague, and in such a tiny community this meant that barely a household escaped. Fortunately, in London the pestilence was on the wane, for as often happened the plague burned itself out. The Court returned from Oxford and week by week the city filled up and became alive again.

London would take a long time to recover, but not so long as Eyam, which had sacrificed itself, and suffered so terribly, in order that its neighbouring villages should remain healthy. Probably these simply Derbyshire men and women never considered that they were doing anything out of the ordinary, but their neighbours remembered them with gratitude, and three hundred years later Eyam remains as a memorial to the heroism of ordinary folk.



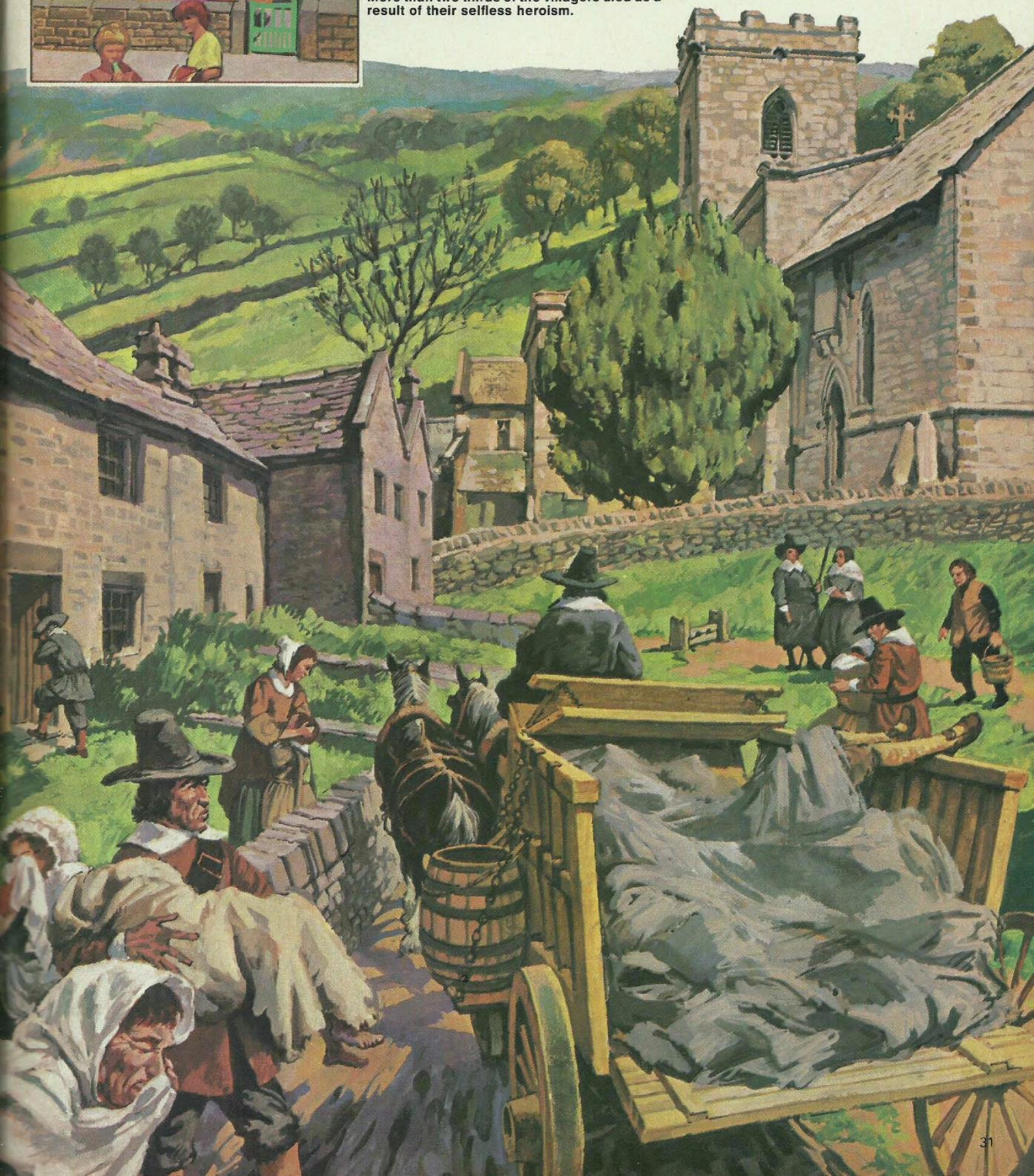
Whilst the victims of the Plague had to be buried, the survivors had to be fed. Food was left at special stones around the village, and the money to pay for it was placed in troughs of vinegar in the belief that this would free it from contamination.

MONUMENTS TO YESTERDAY



Eyam today is a popular tourist attraction, both for its natural beauty and its unique history. The plaque on the wall of the cottage (left) commemorates the first victim of the Plague.

More than two thirds of the villagers died as a result of their selfless heroism.

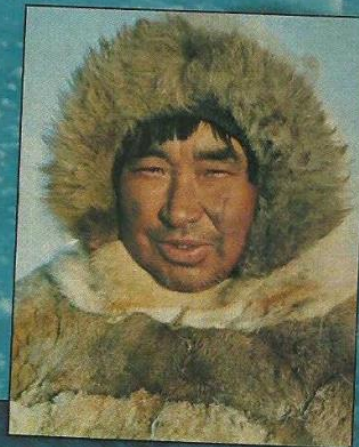




Waiting For The Walrus

Somewhere beneath the ice swims the prey of these Eskimos of Greenland

Kaugunak Kissuk, one of Siorapaluk's best hunters.



The sound of a walrus at its breathing hole will galvanise these hunters into instant action.

WITH their harpoon lines clenched between their teeth, two hunters wait patiently. The men are Eskimos of north-west Greenland, hunting walrus.

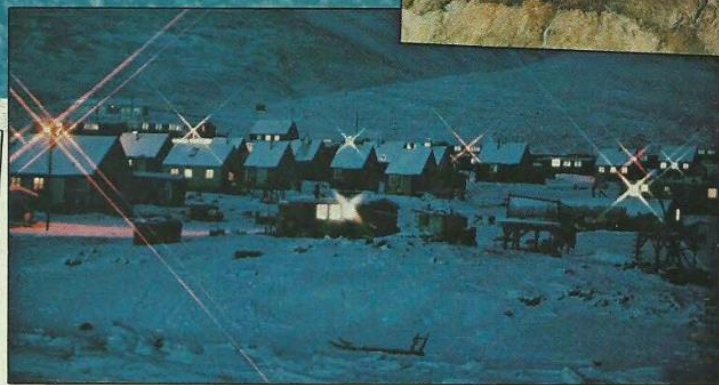
Walrus are greatly prized by the Eskimos because they can provide up to 1,000 kg of meat each. Hunting them during the winter is often dangerous.

It may be necessary for the hunter to walk for several hours on recently formed sea ice, barely strong enough to stand his weight. All the time, he is listening for the tell-tale snorts of a walrus at its breathing hole.

If the hunter manages to get close enough to a walrus undetected, he has to throw his harpoon with sufficient force and accuracy to penetrate its hide.

May brings the highlight of the year to the Eskimos in Greenland, when millions of Little Auks arrive to breed on the mountains. The people lose little time in setting out to catch them. They do this by concealing themselves among the rocks and, with the aid of a net lashed on to the end of a long pole, they scoop the birds out of the air as they fly past.

These pictures were taken in and around the village of Siorapaluk, which has a Lutheran church which also serves as a schoolroom. It is a close-knit, happy community amid the northern snows.



The village in winter — at midday. Left: the Lutheran pastor and his church. Right: an Eskimo mother with her catch of Little Auks. She caught them with a net at the end of a long pole, as shown below.



BRYAN ALEXANDER

21512

Australia 40 cents, New Zealand 40 cents,

South Africa 40 cents, Canada 45 cents, Malaysia \$1.20.

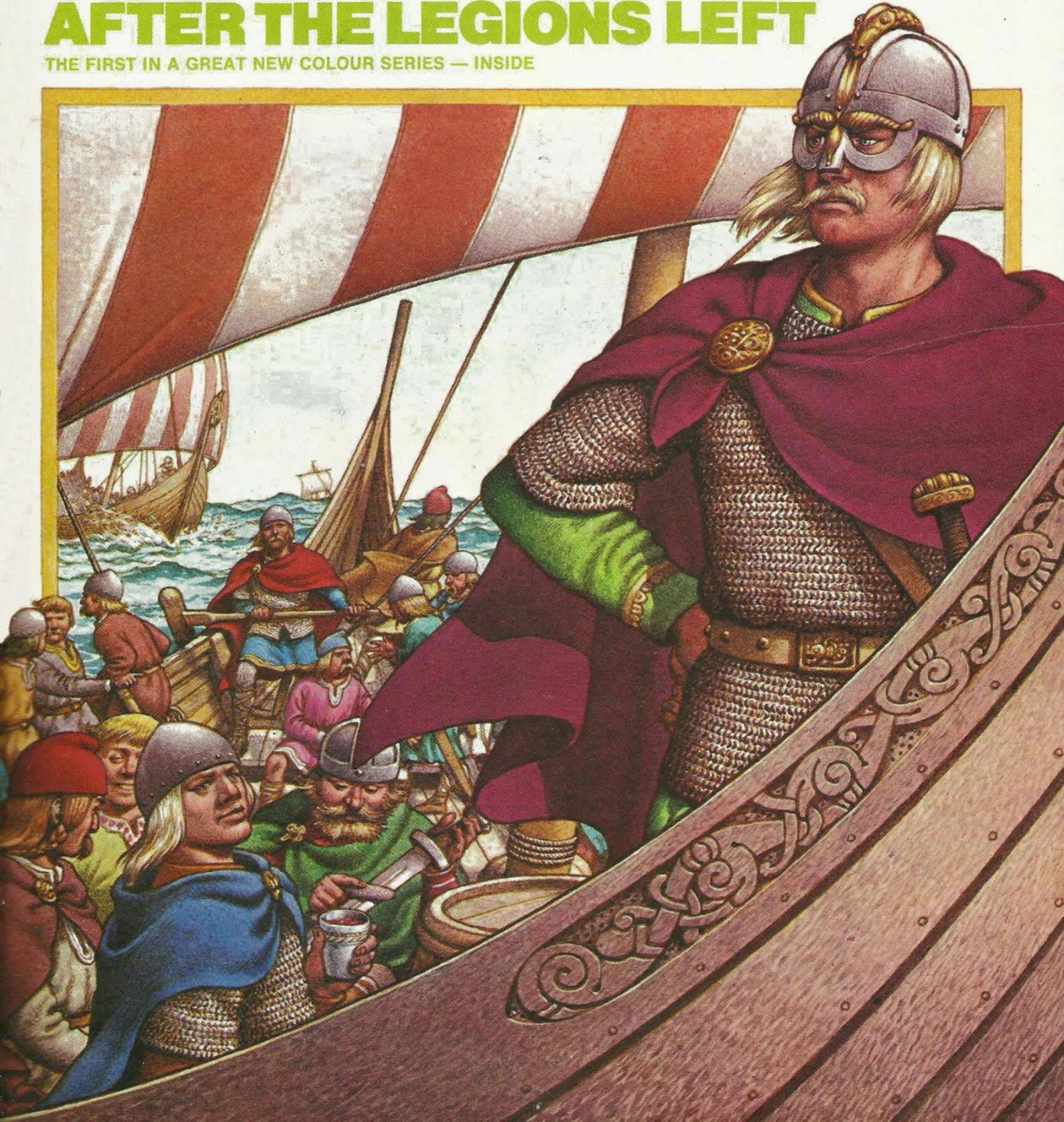
THE MAGAZINE FOR ALL THE FAMILY **LOOK AND LEARN**

No. 872, 30th SEPTEMBER, 1978.
EVERY MONDAY PRICE 20p.

The Miniature Invaders! SEE PAGE 4

AFTER THE LEGIONS LEFT

THE FIRST IN A GREAT NEW COLOUR SERIES — INSIDE



Turning The Sandy Tide

Experiments with trees in the Sahara Desert provide real hope that one day it will become what it was 10,000 years ago — a lush land of river and pasture

DESERTS could become lush pasture lands early in the next century when nations fringing these barren bowls realise that they can be made to come alive with trees, vegetables and flowers.

A start has already been made to beat back the advancing Sahara, although the evidence that people can dwell happily among sandy dunes and rocks has been provided for many years by Israel.

Since 1948, when the State of Israel was created, the Israelis have shown how arid land can be turned into farms. During the past 30 years, irrigation schemes have added over 150,000 hectares to the farming areas that existed when Israel was born. Forests have increased tenfold.

In the occupied Sinai desert, settlements have sprouted along the Mediterranean coast. The burning sandy wastes on which these small townships were built have yielded to the scientific farming methods introduced by the Israelis. The town of Yamit, for instance, is known as "the paradise of the south". The 1,500 people who live there are planning to build a sports centre, youth clubs and other facilities to cope with the expected rapid growth of population in the next few years.

The Israelis have indeed demonstrated to the world that the desert need not be a wasteland. So too has a middle-aged British woman, Wendy Campbell-Purdie, who, inspired by an English tree expert, Richard St. Barbe Baker, has been planting trees around the edge of the Sahara for years. These are destined to form the forests of the future.

Many African nations have sought her guidance after seeing the hundreds of trees she has had planted providing shade for crops and animals and

keeping the sand at bay. She was working for a timber firm in Corsica 17 years ago when St. Barbe Baker convinced her that his idea of a "green wall" could tame the desert. Now in his eighties, he has devoted his life to the protection and development of trees throughout the world.

Miss Campbell-Purdie set out to beat back the Sahara all on her own. She went to Morocco, rented 18 hectares of desert and started to plant trees in the sand.

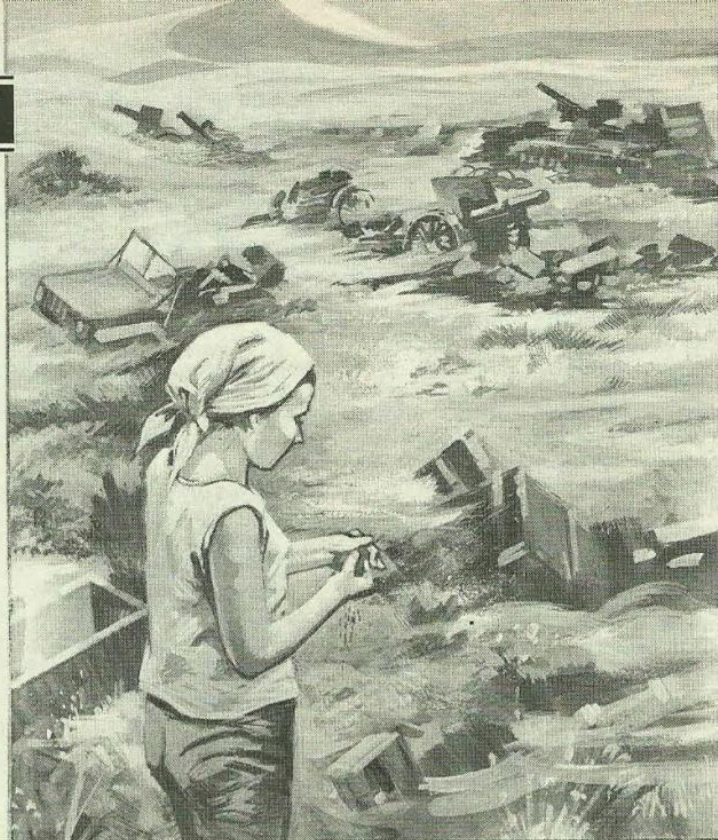
Ignoring the Arabs' scepticism, she planted 2,000 trees at the town of Tizuit. Her studies had shown that they would be a barrier to sandstorms, cool the air and increase the moisture on the surface of the land to help it become fertile again. In four years, after careful irrigation, the trees were four metres high. In their shelter, Miss Campbell-Purdie grew wheat and barley.

Difficulties

Then she travelled to Algeria where she met with no sympathy from officialdom. But with determined argument she finally persuaded government officials to give her some land to demonstrate her tree-planting idea.

Miss Campbell-Purdie was offered a 100-hectare area of sandy land which had once been a French military dump. It was still covered with scrap metal. There she planted 1,000 seedlings; a year later, 800 were still alive.

Astonished by her success, the Algerian government offered her unlimited seedlings to be grown on the old arms dump which had yielded to her green fingers. In England, money was raised for the new project; in Algeria, officials promised labour to help with



Illustrated by David Dimmock

A desolate old arms dump in the Algerian desert was the site of one of the most successful experiments in using trees to beat back the desert. Right: deserts may one day become simply historical curiosities as man turns the arid wastelands into prosperous farming regions.

the planting.

To Miss Campbell-Purdie, the day the thousands of volunteers arrived, headed by a three-piece band, was quite unforgettable. As she said: "It was the most glorious day of my life. I almost burst into tears."

Today, her 130,000 trees are flourishing. The fertile area they created grows vegetables, grain and citrus fruits. It has given the villagers work and wealth. And it inspired the Algerian government to plant an enormous wall of trees 12 kilometres wide across the country from border to border.

Since then, Miss Campbell-Purdie has visited Senegal, on the southern edge of the Sahara, where a similar cross-country wall of trees is being grown. The adjoining country of Gambia has sought her advice and so has Botswana, which would like to see trees growing in the Kalahari desert. Egypt has also been studying Miss Campbell-Purdie's methods for making the Sahara the green land it was 10,000 years ago.

By planting trees on the perimeter of the desert and then by spreading the growth of trees inwards, she argues that it is possible to spread vegetation until it almost entirely covers the world's biggest desert. It once supported people with pastures and rivers, and can surely revert to that happy state.

Strangely enough, obtaining water is not a great problem in

the Sahara. There is plenty beneath the sands, although it is a long way down. It requires wells to bring it to the surface. Oases that dot the desert provide the key to the position of subterranean water supplies. These, linked to the tree-planting scheme, could end the starvation and misery that afflict many desert communities.

Chinese Oasis

There are examples of people living successfully in hot places surrounded by desert. Deep in central Asia lies Turfan, in China's driest region. Yet it is a green oasis of sparkling streams and orchards. Nearly 150,000 people live in Turfan, which is in the midst of a stony desert.

Nicknamed "the oasis of fire", Turfan's seven farms depend on underground irrigation canals to channel water from rivers some distance away. The expansion of this irrigation system, which in parts is 1,700 years old, is said to have enabled the doubling of farmland since 1950.

Miss Campbell-Purdie has not been alone in knowing the secret of making deserts habitable. But, by capturing her missionary zeal, governments of nations dotted around the world's equatorial belt where deserts are found could find the answer to the problems of growing food and providing homes for their people.



KODAK CAMERAS TO BE WON!

**SEE
INSIDE**

LOOK AND LEARN

The Man Who Sold His Country

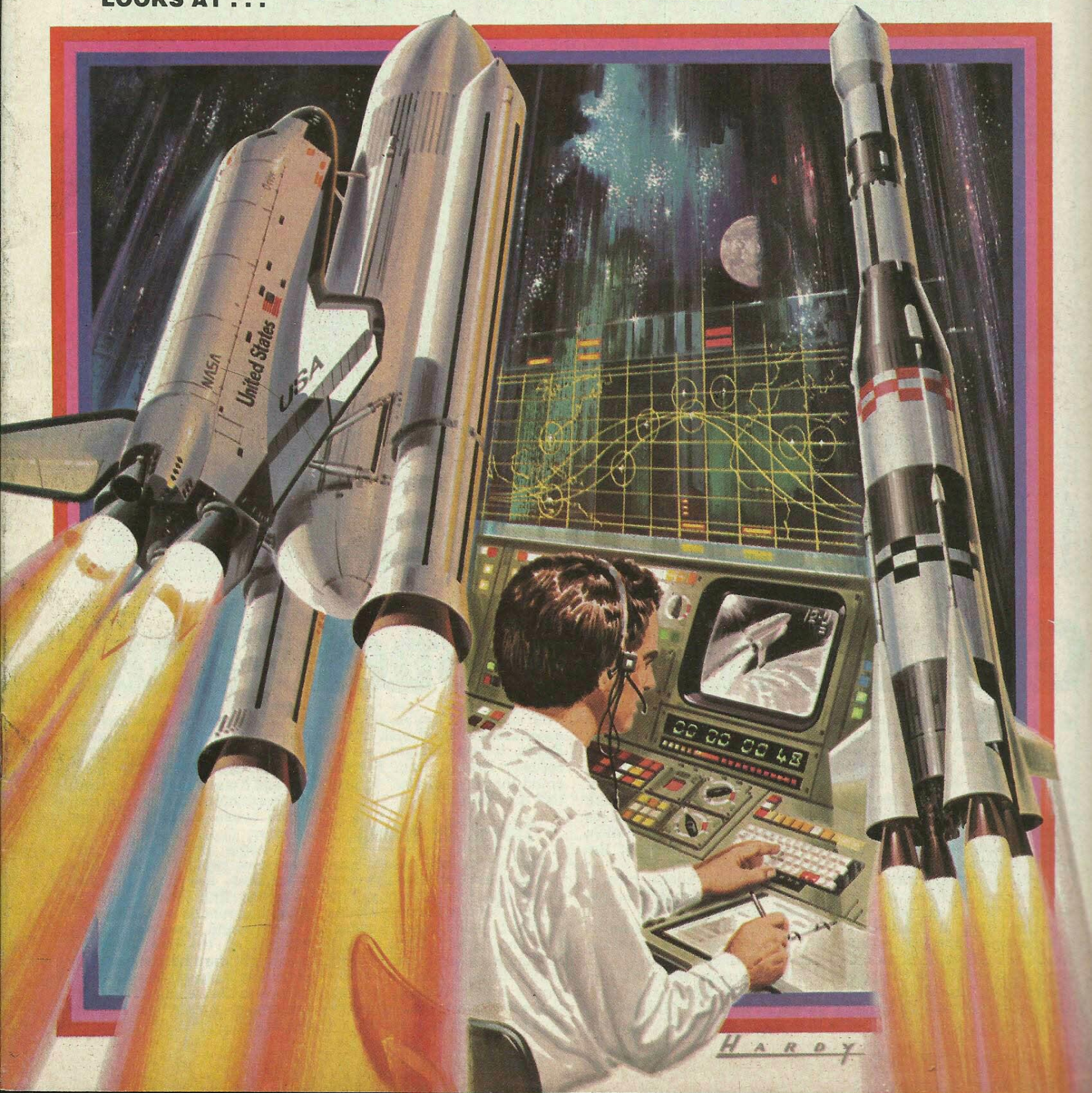
ANOTHER IN OUR 'BETRAYERS' SERIES - SEE PAGE 8

**THIS WEEK'S
INSIDE STORY
LOOKS AT ...**

No.880, 25th NOVEMBER, 1978.
EVERY MONDAY PRICE 20p

Australia 40 cents, New Zealand 40 cents,
South Africa 40 cents, Canada 45 cents, Malaysia \$1.50.

THE ROCKET RIVALS





The classic step-rocket flight of an Ariane, shown in diagrammatic form. It starts with the complete multi-stage launcher (as shown in the cutaway drawing) and finishes with the third stage delivering the payload satellite into orbit.

INSIDE STORY

The Rocket Rivals

Ten nations have sponsored a European rocket-launcher which is designed to put space craft into orbit more cheaply than its American rival, the space shuttle

SPACECRAFT destined to explore distant planets may be put into an interplanetary trajectory by a launcher currently being developed by ten European countries, of which Britain is one.

Named Ariane, it is a three-stage rocket, and is cheaper to operate than its closest rival, the American shuttle, which can be flown back to Earth like a conventional aircraft after being launched like a rocket.

Ariane is the largest and most complex space project to be tackled in Europe since the late 1960s and it is designed to cut the cost of putting satellites into orbit.

The first two stages are fuelled with a combination of nitrogen tetroxide and unsymmetrical dimethyl hydrazine. The high energy third stage burns both liquid oxygen and liquid hydrogen.

Four Viking 5 motors provide the thrust to give the rocket lift-off. They are steerable. Should one fail in flight, the remaining three could continue to operate.

The second stage has a single Viking 4 engine with a large

bell-shaped nozzle designed to operate at its best in a near-vacuum.

Powering the third stage is an SEP HM7 rocket motor which has six hydrogen jets to provide thrust for attitude control. These accurately position the stage before the payload — a satellite — is released into orbit. This occurs after two half-shells encasing the payload have been blown apart.

Ariane will be launched from a site in Kourou in French Guiana. This is an ideal place from which to put a satellite into an orbit synchronised with the Earth's rotation.

About 850 people will be needed to operate the launching base, with others manning tracking stations in Natal, Brazil and on Ascension Island in the South Atlantic.

The entire operation from lift-off to the separation of the third stage will take under five minutes, and the third stage will then burn for 9 minutes 30 seconds to rise high enough to put its payload into orbit.

When this happens, the third stage is manoeuvred out of the way, its task completed.

Payload protection fairing

Control instruments and antennae

Third stage liquid hydrogen and oxygen tanks

Third stage HM 7 engine

Second stage nitrogen tetroxide tank

Second stage UDMH tank

Water ring for hot-gas fuel pump

Second stage Viking 4 engine

First stage nitrogen tetroxide tank

External nitrogen tetroxide feed lines to engines

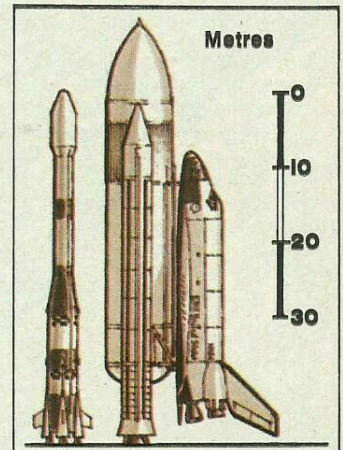
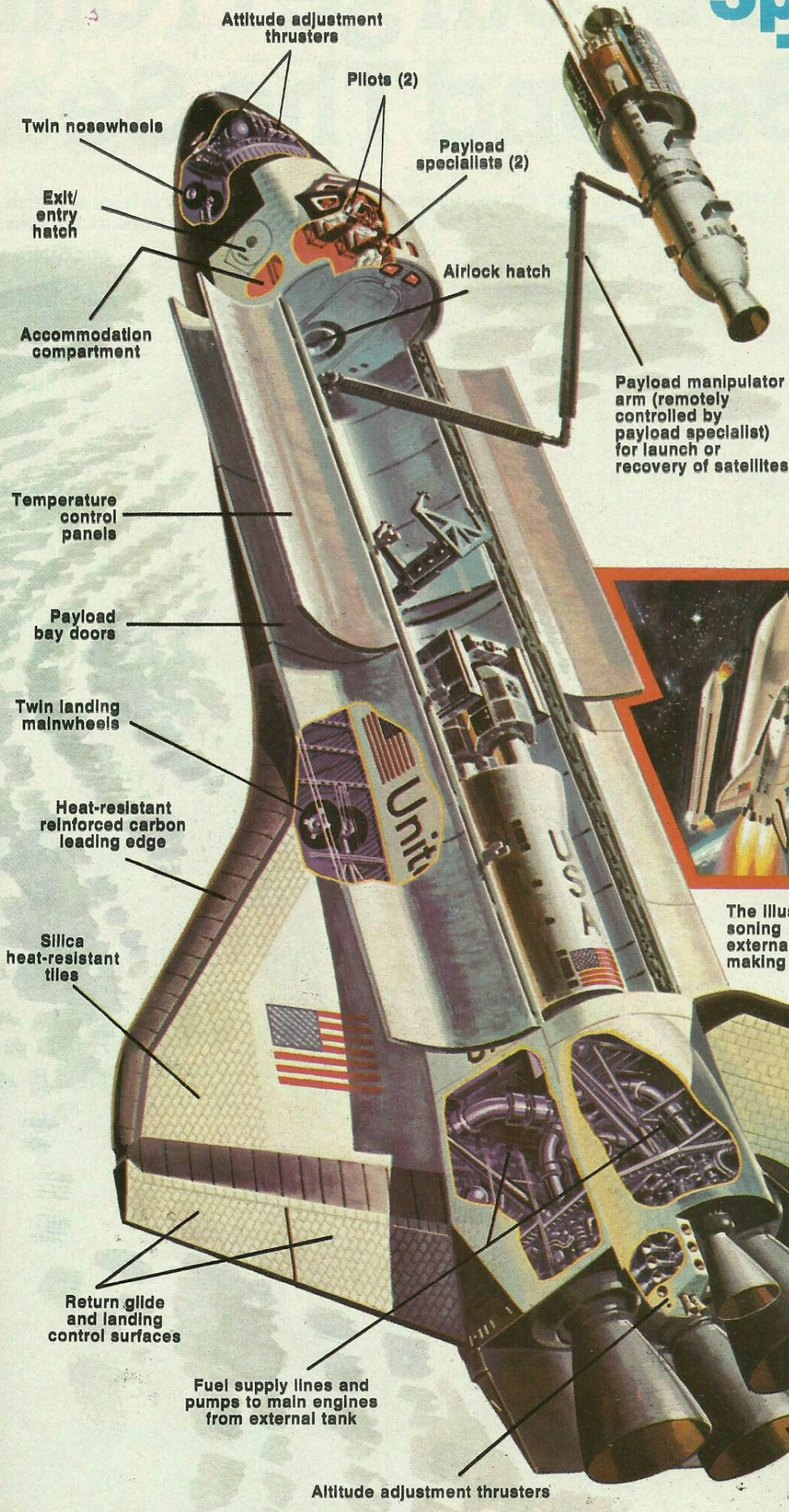
First stage fuel tank (Unsymmetrical Dimethyl Hydrazine — UDMH)

Water ring for hot-gas fuel pumps

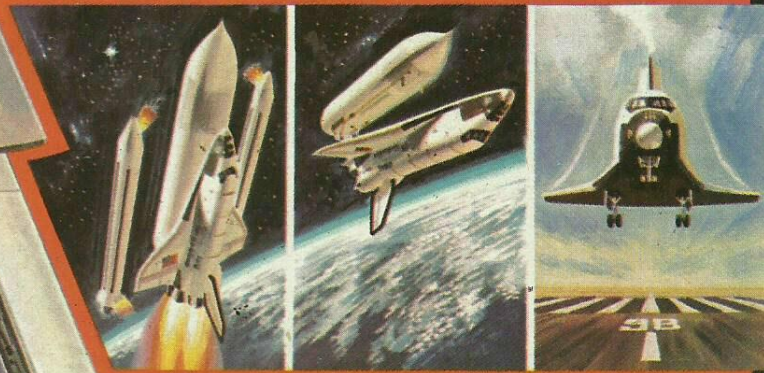
Stabilising fins

First stage Viking 5 engines, steerable for flight control

Space Shuttle To The Stars



How the two rivals measure up: left, the Ariane and, right, the space shuttle.



The illustrations above show, left to right, the shuttle jettisoning its solid-fuel booster rockets, releasing its main external fuel tank and, after re-entry into the atmosphere, making its glide landing.

Heat-resistant reinforced carbon edge

Rudder/air brakes for landing

Orbital adjustment engines (2)

Main engines (3) used for take-off only

Altitude adjustment thrusters

Fuel supply lines and pumps to main engines from external tank

Return glide and landing control surfaces

Silica heat-resistant tiles

Heat-resistant reinforced carbon leading edge

Twin landing mainwheels

Payload bay doors

Temperature control panels

Accommodation compartment

Exit/entry hatch

Twin nosewheels

Attitude adjustment thrusters

Pilots (2)

Payload specialists (2)

Airlock hatch

Payload manipulator arm (remotely controlled by payload specialist) for launch or recovery of satellites

SUPER **GRANDSTAND** TV GAMES TO BE WON! SEE INSIDE

LOOK AND LEARN

THE SPY
WHO FOILED
A MASSACRE

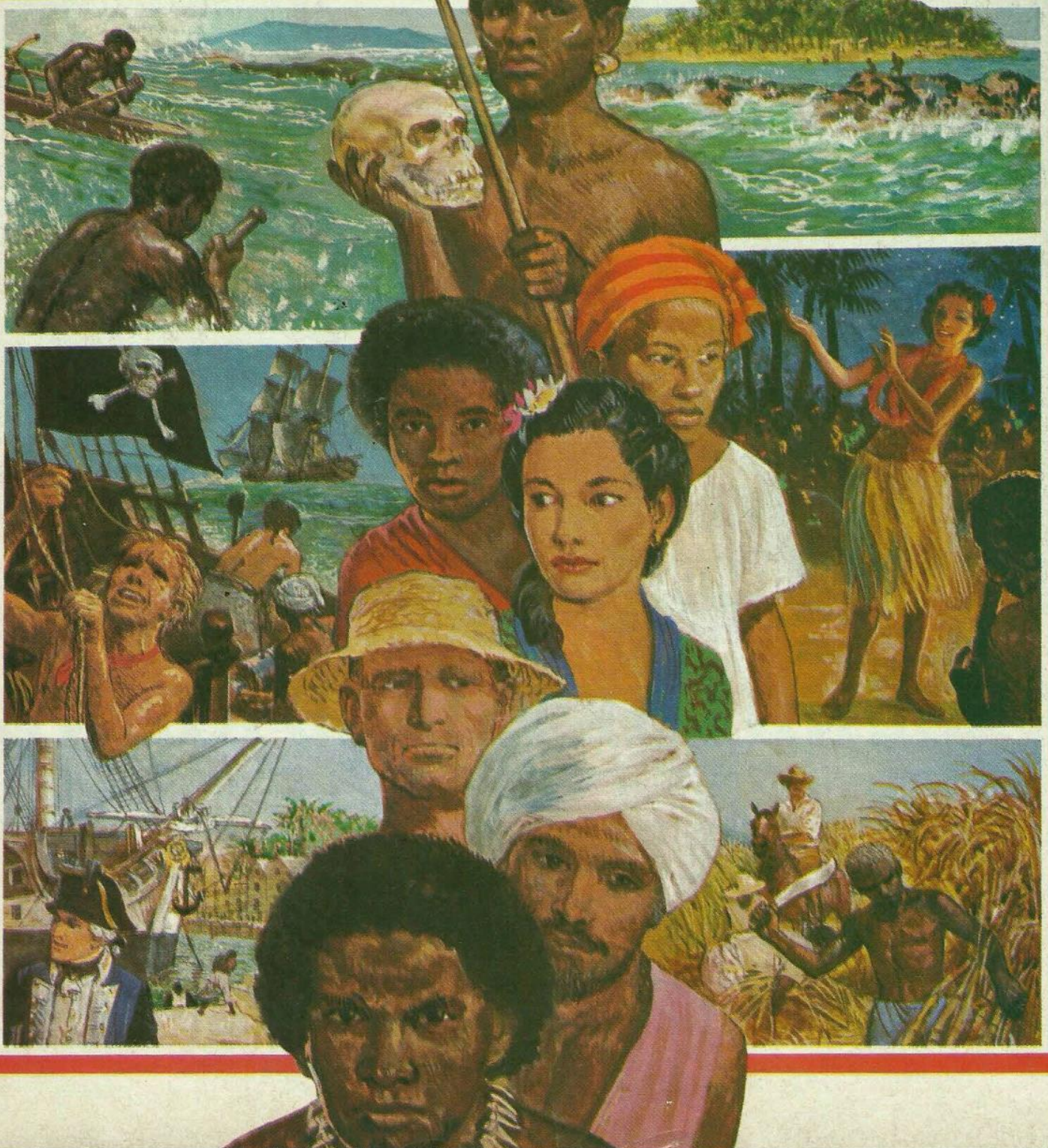
THIS WEEK'S 'ON TRIAL' STORY — SEE PAGE 22

No. 883, 16th DECEMBER, 1978.
EVERY MONDAY PRICE 20p

Australia 40 cents, New Zealand 40 cents,
South Africa 40 cents, Canada 45 cents, Malaysia \$1.50

They Belonged To Britain

A NEW SERIES BEGINS ON PAGE 20



UNDER THE MICROSCOPE

'Diamonds' From The Sky

Every colour of the spectrum can be reflected from the snow crystals' many facets, giving them a brilliance to rival any gemstone

WHEN you pick up a handful of snow to make a snowball, you are handling one of nature's most beautiful and delicate creations. It may not always look that way, especially when it has been trodden into slush on city pavements. It needs a close look at fresh-fallen, dry snow to reveal its true nature.

It is important to realise that snow is not "frozen rain". Some knowledge of what causes rain will help to understand how snow is formed.

In certain conditions, the air reaches a state when it becomes saturated with water vapour. This means that it holds more than it can readily contain, and the invisible vapour tends to condense into liquid water. This takes the form of minute droplets, which float in the air as clouds. When these droplets unite to make larger drops, rain is formed.

When the temperature is below freezing point, as at very great altitudes, the surplus water vapour turns directly from the vapour form into ice. When this happens, minute crystals are formed.

Very high clouds, such as the cirrus ones shown below, are composed of ice crystals similar to those which fall as snow. Snow crystals take the many wonderful shapes at the bottom of these pages



Very high clouds, such as the cirrus clouds which form "mares' tails" or "mackerel skies", are composed of such crystals. Some of these take the form of fine needles of ice, which may be no more than one two-hundredth of a millimetre in diameter.

The snow that falls to the ground is composed of ice crystals. Their form and size varies greatly, depending partly on the temperature at which they are formed. The shapes include not only "needles", but also hollow, prism-shaped columns and "dendritic", or tree-shaped, clusters of needles.

The most elaborate and beautiful snow crystals are not produced at the lowest temperatures. These are the ones which we are most likely to see in fallen snow, and which take the form of six-sided "plates" or six-pointed stars.

An unbroken six-sided, or hexagonal, plate is the complete form of such ice crystals. The shape is due to the way oxygen atoms arrange themselves within the ice. But the complete form is seldom seen. More often

the crystals appear in lacy, incomplete form — yet always showing a symmetrical hexagonal pattern. No two snow crystals are precisely alike.

Owing to the diffraction of light rays that penetrate them, ice crystals do not appear transparent, but white. Every colour of the spectrum can be reflected from their many facets, giving them a brilliance to rival any gemstone.

Sparkling Shower

In very cold temperatures, crystals may remain separate and float in the air, or even fall to earth, as a sparkling shower of so-called "diamond dust". In the extreme climate of the Antarctic, such showers are often produced from water vapour close to ground level, so that it seems that snow is falling from a cloudless sky.

Generally, however, ice crystals, like water droplets, must unite to form larger bodies before they will fall. Ice crystals combine into snow-flakes. Their individual patterns can sometimes be detected with the naked eye, especially in the powdery snow that falls under dry, crisp conditions.

When snow settles on the ground, the open texture of the crystals causes a considerable amount of air to be trapped within and between them. This makes a blanket of snow a poor conductor of heat, and slows down the escape of warmth from the soil. This is an important factor in agriculture in countries which, like Canada, have a severe winter.

The actual volume of water in a layer of snow is comparatively small. In falls such as those generally experienced in Britain, a depth of 15 centimetres of snow, if melted, would produce only about one centimetre of water.

Not all the ice crystals we see

are those which fall as snow. Just as water droplets and raindrops result from condensation in the upper air, water vapour may condense at ground level. The droplets settle as dew on plants and other surfaces. If the temperature is below freezing point, a layer of ice crystals is deposited instead of dew. This deposit is called hoar frost.

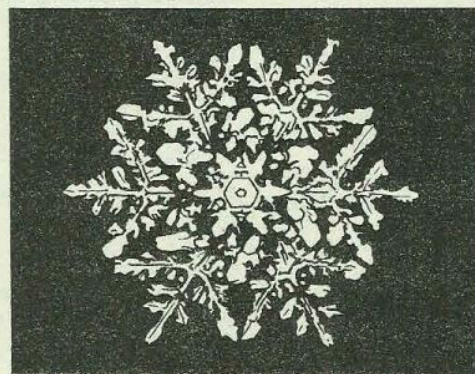
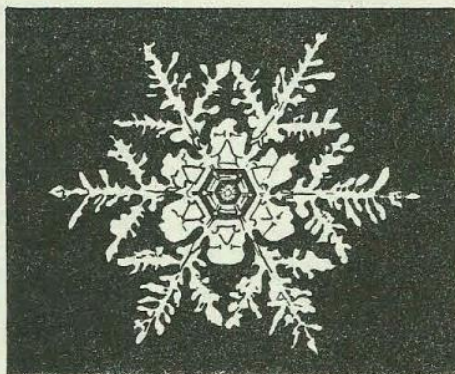
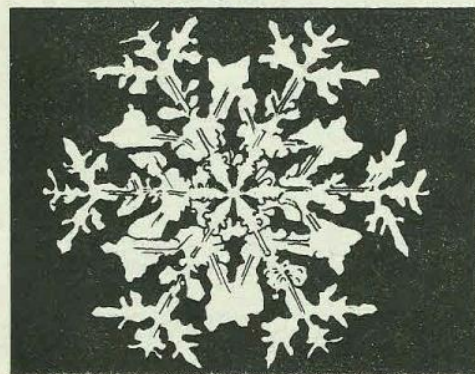
It often occurs that snowflakes, at some point in their descent, pass into a zone of high temperature which causes them to melt. In this case they fall to the ground as raindrops. Sometimes only the smaller flakes are completely melted, so that we have a mixture of rain and snow, or sleet, as it is called.

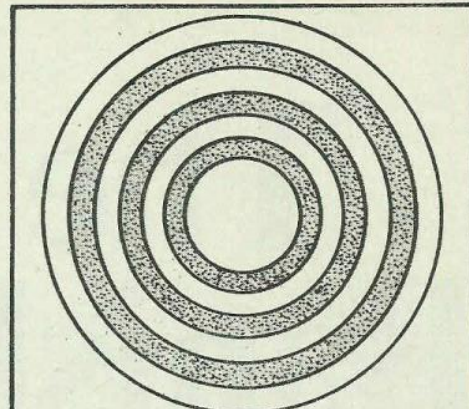
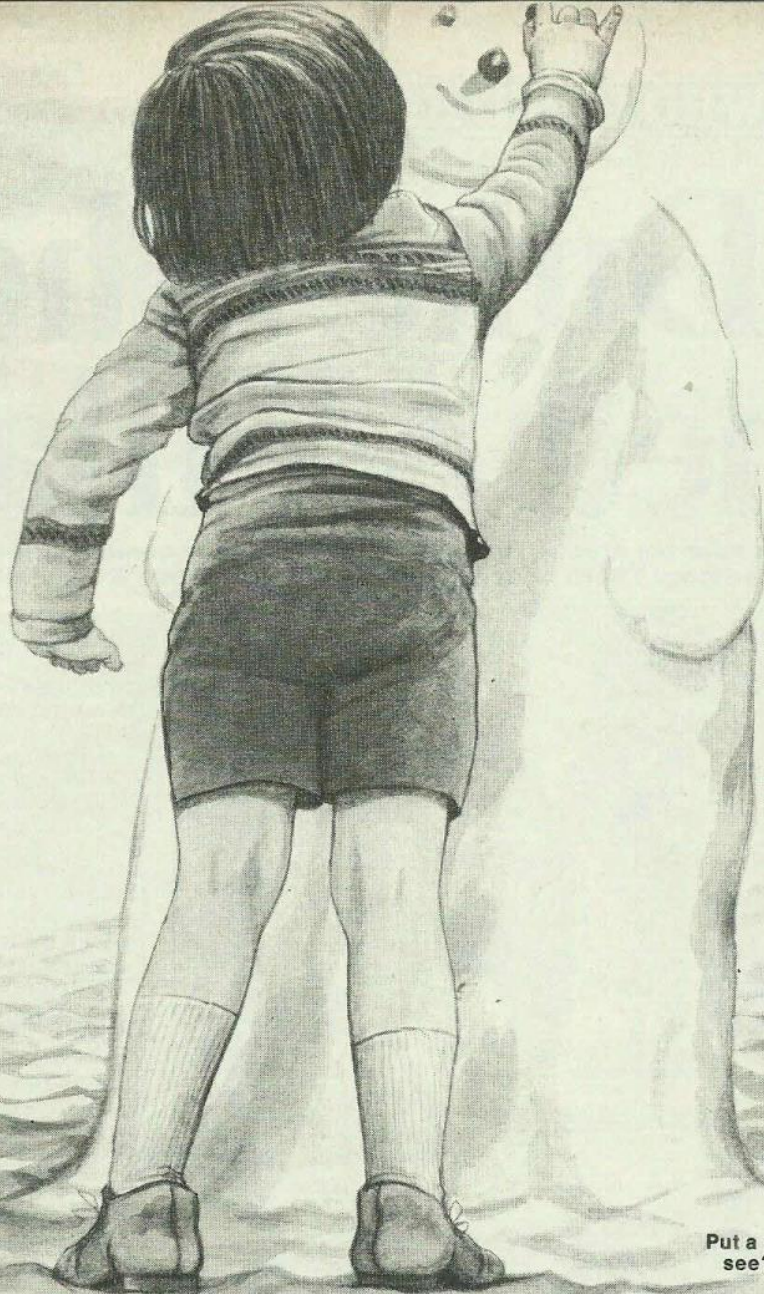
Hail, the other form in which ice falls from the air, originates in a different way from snow. A hailstone starts as a raindrop. During its descent it is caught in the up-draught of air which exists in many rain-clouds, especially the towering cumulo-nimbus storm clouds.

The drop is carried up till it reaches an altitude where the temperature is low enough to turn it into ice. The frozen raindrop now falls, picking up on the way a layer of ice crystals, and on top of that, a layer of liquid water. Again it is carried up by the up-draught. The fresh layer of water is frozen, and a further layer of crystals added.

The process may be repeated several times before the hailstone finally falls to earth. Hailstones may be smaller than peas or as large as tennis balls. If examined before they melt, they can be cut through to reveal the succession of "skins" of hard and soft ice of which they consist.

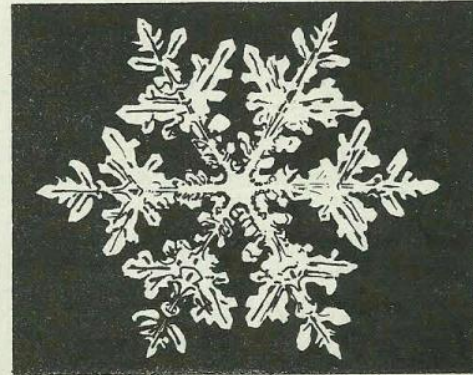
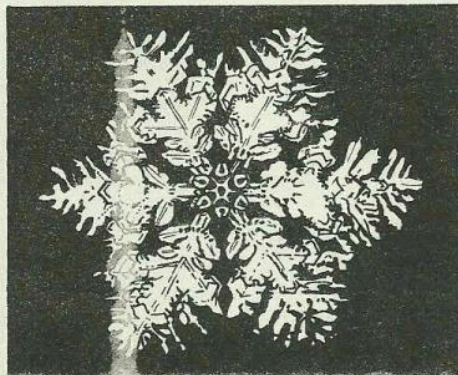
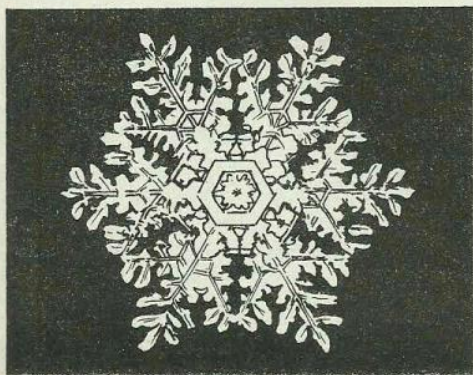
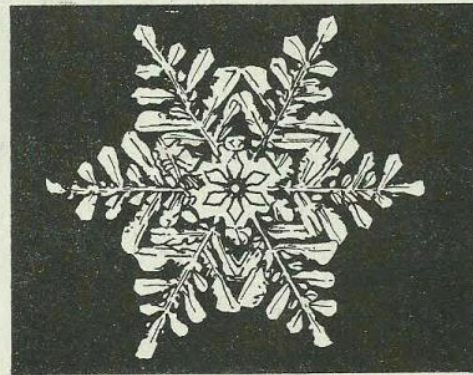
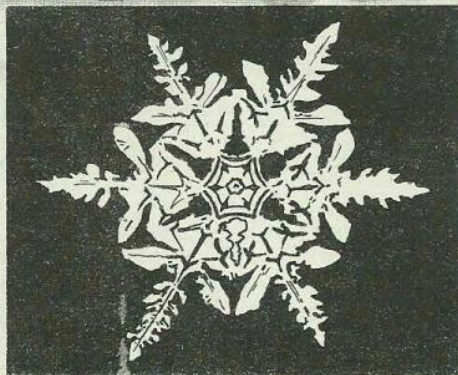
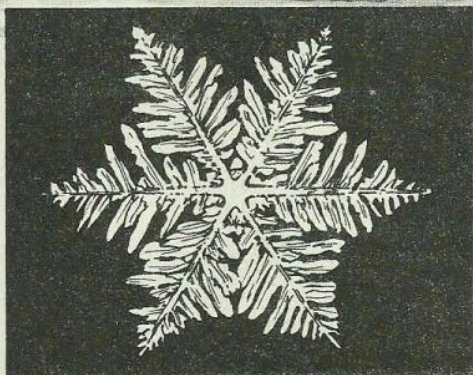
Hail is frequently a feature of summer storms. This reminds us that, even when we are having warm weather, nature's ice-making processes continue high above us.

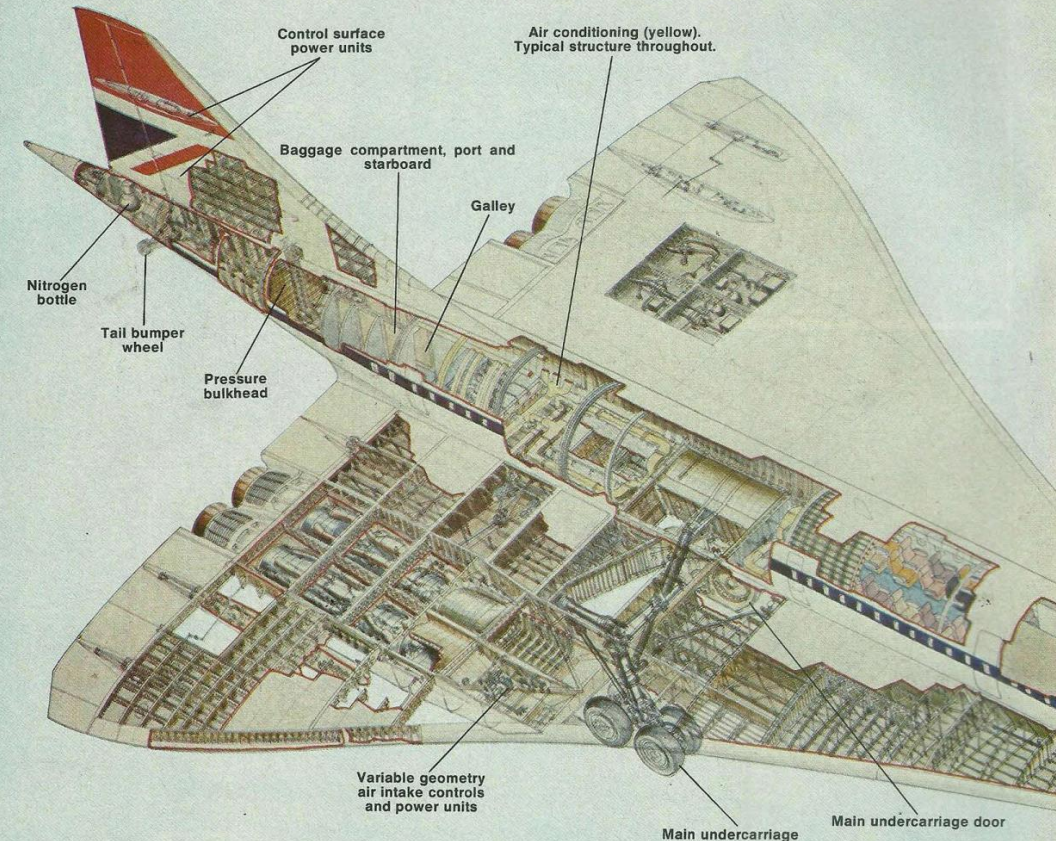




How a hailstone builds up. In the centre is the original frozen raindrop. As it rises and falls through different temperature zones, it picks up alternate layers of ice crystals and of liquid water which freezes. The shaded rings represent layers of soft ice. The other rings are layers of hard ice.

Put a snowman under the microscope and what do you see? Beautiful crystals like the ones pictured below.





All the features which make a great plane are shown in the detailed drawing above. An idea of the Concorde's size can be gauged by comparing it with the fuelling vehicle, bottom left. Below is the flight deck with its mass of dials and controls.



INSIDE STORY

Built To Beat The Barrier

Modern aerotechnology and revolutionary materials make it possible for Concorde to fly at twice the speed of sound

LONDON to New York in just under 3½ hours at twice the speed of sound... only one aircraft is regularly performing this feat. And that is Concorde, the supersonic airliner, developed jointly by Britain and France.

As it soars through the air powered by its four mighty Olympus engines, the centre of lift moves towards the rear. To avoid the tail end of the plane lifting and causing greater drag, which would make the plane harder to control, fuel is pumped between the main tanks and forward and aft trim tanks.

This is only one of the ways in which Concorde differs from subsonic aircraft. Another is in

the use in the engines of metals which can withstand extremely high temperatures. Titanium is used for the low-pressure compressor and the first stages of the high-pressure compressor where the temperature reaches 550 deg. C. There are even higher temperatures back in the engine, and nickel-based alloys are used here.

Concorde's history goes back to 1962 when Britain and France signed an agreement to design and manufacture Concorde jointly. The prototype first flew on 2nd March, 1969, and the first flights with fare-paying passengers were on 21st January, 1976, from London to Bahrain, and Paris to Rio de Janeiro.

The first flights to the USA were made to Dulles Airport, Washington. Then, after a long legal battle, came the authorisation to fly to New York.

People seeing the aircraft for the first time noticed the distinctive feature of its droop nose. To avoid obscuring the view of the flight crew on landing and take-off, the nose is lowered.

At supersonic speeds, the

nose is raised, together with a visor which, in high speed flight, protects the flight deck windows.

Before it could go into service, Concorde had to be tested in every type of operating environment. Two prototypes and two pre-production Concorde were made.

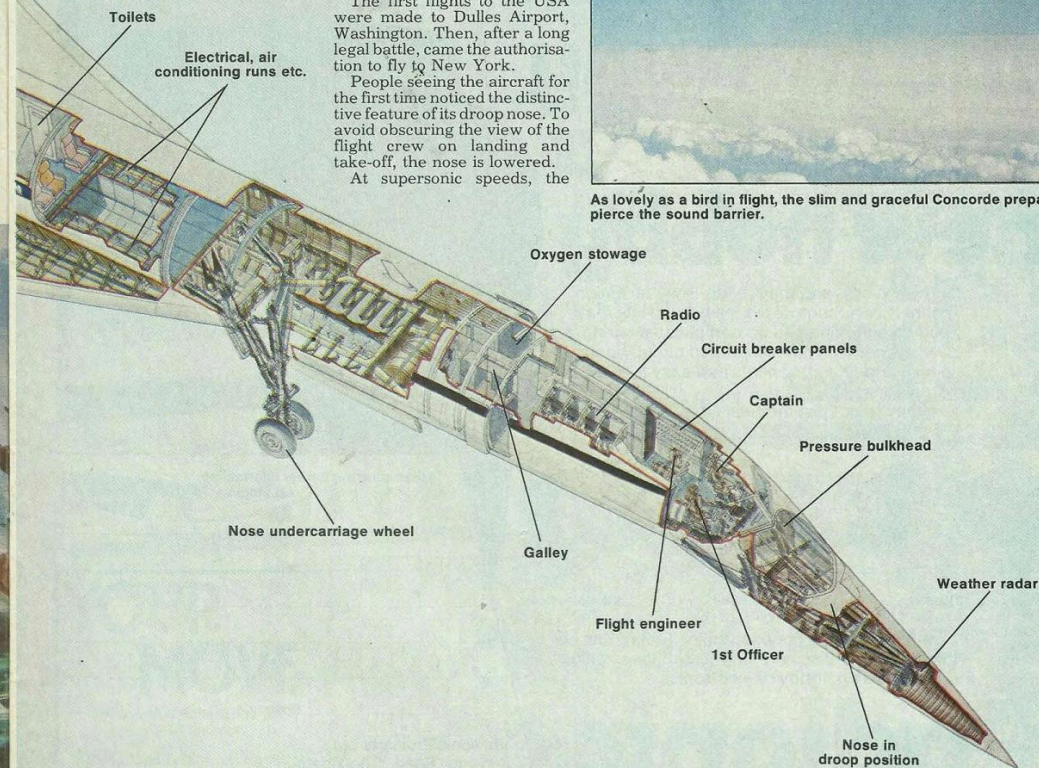
Measurements were made of

3,000 different things, including pressures, temperatures, accelerations and altitudes. All of these measurements were recorded on magnetic tape in the plane for analysis on the ground later.

Tests of many other parts of the aircraft were monitored before the craft was considered ready to carry passengers.



As lovely as a bird in flight, the slim and graceful Concorde prepares to pierce the sound barrier.



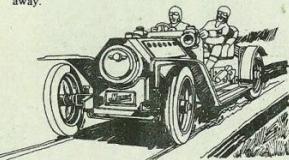
MAMOD STEAM MODELS-

THEY REALLY
WORK

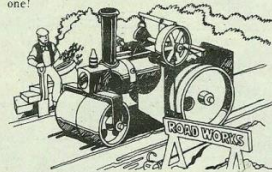
Deliver the goods with this splendid Steam Wagon. Highly efficient engine and wonderfully realistic including whistle and exhaust steam from the chimney. Heavily built (Gross weight 6 lbs) to carry your loads with ease.



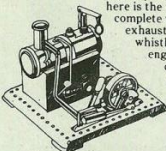
Journey back to the early 20th Century - motoring's proudest era - with this sensational Steam Roadster (15 1/2" long). Imagine yourself in the driving seat. Boiler filled, engine oiled, fuel ignited, pressure up, into gear - and you're away.



This workaholic Steam Roller is as powerful and robust as it looks. Sturdily constructed with precision metal parts, it will chug merrily along backwards or forwards - just like the real thing. Steam-roller. Dad into buying you one!



Drive your Mamod or Meccano working models with one of our range of stationary engines. Illustrated here is the fabulous model SE2a, complete with reverse lever, exhaust to chimney and whistle. Like all Mamod engines, this gives you exceptional performance and quality at a moderate price.



Mamod
WORKING STEAM MODELS

NATURE'S KINGDOM

In Search Of A Legend

For centuries seafarers have told tales of giant squids which inhabit the dark world beneath the sea. But do they really exist?

SQUIDS are marine animals closely related to octopus and cuttlefish and, more distantly, to snails, cockles and mussels. They are invertebrate animals, and are classified as molluscs.

The body of a squid is shaped rather like a torpedo. The head carries ten arms of which two, known more accurately as tentacles, are very long and can be extended to a length greater than the rest of the body. All the arms have circular toothed suckers.

Most of the squids — and there are many different kinds distributed throughout the oceans of the world — are quite small.

The common squids around the coast of Britain are less than a metre long, including the tentacles.

But there are some which are much larger and these are known as giant squids. Very little is known about these because they are virtually impossible to catch by ordinary fishing methods.

They have attracted attention on the few occasions when they have been stranded on shore or when found in the stomachs of sperm whales which feed on squids of all kinds.

There are many stories of giant squids attacking ships and even capsizing them. Most of these are grossly exaggerated, but it is likely that a boat could be overturned by a large specimen.

On one occasion, a French warship sighted a giant squid off the Canary Islands. This at last provided some evidence for the scientists who, for a long time, had had

doubts about the existence of giant squid.

In 1871, a specimen with tentacles eight metres long and a total length of ten metres was captured off the coast of Newfoundland. Fortunately, instead of cutting it up for bait, the fishermen took it to a local parson who measured it and then photographed it.

Mammoth Meal

An even larger specimen, said to measure about 19 metres overall, was stranded at Lyall Bay in New Zealand in about 1888.

One of the most authentic records is of more recent date. In 1955, Robert Clark, a biologist, was examining sperm whales caught by the whalers off Fayal in the Azores. On 4th July of that year they landed a 15 metre long whale, and in its stomach Clark found an intact squid 11 metres long.

Some people think that there may be giant squids measuring perhaps 21 metres, but so far no specimens have been caught.

But it is not impossible for such giants to exist, for sometimes sperm whales which have fought with giant squids are scarred with circular marks made by the tentacle suckers.

We know that a six-metre squid has suckers 25 mm. across, but sperm whales often show sucker marks that are 88 mm. across.

If sucker size increases in proportion to total body length, then it is not at all impossible that these marks could have been made by a squid about 21 metres long.

Illustration by Susan Canwright



ADVENTURE-SCIENCE-NATURE-PEOPLE-PLACES

Australia 40 cents, New Zealand 40 cents,

South Africa 40 cents, Canada 45 cents, Malaysia \$1.50.

LOOK AND LEARN

Wheels Of Victory

THIS WEEK'S STORY FROM THE WORLD OF
MOTOR RACING IS ON PAGE 30

No. 887, 20th JANUARY, 1979.
EVERY MONDAY PRICE 20p.

Heroes Of The High Seas

— SEE 'WHO LIVED HERE?' — PAGE 22

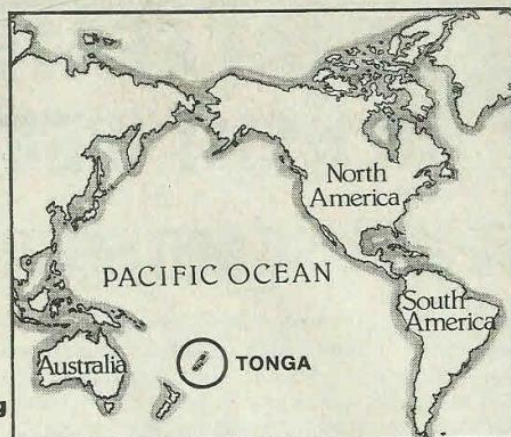


THEY BELONGED TO BRITAIN

This week we visit the islands of Tonga

Island Queen Who Conquered With A Smile

On a grey London day, a Queen from far across the Pacific ignored the pouring rain and won the cheers of the waiting Coronation crowds



THE rain started just as Queen Elizabeth's coronation cavalcade set off from Westminster Abbey for her triumphal return to Buckingham Palace as Britain's newly crowned monarch. On that grey June day in 1953 the crowds had been waiting to acclaim her for long hours. Many had camped out on the pavements overnight. Then, in the early afternoon, the cold rain swept down, making the ceremonial horses prance and buck.

As the Queen, waving and smiling from her golden coach, captured the heart of London, so did another queen riding in an open carriage behind her, ignoring the rain and acknowledging the special cheers from the crowds along the royal route.

Queen Salote of Tonga, a jolly, ample figure in a silver and white gown, admired the stoic loyalty of the coronation throngs so much that she decided to leave her carriage covers down and face the torrent with them. The people loved her for that unselfish gesture. She returned their roars of welcome with laughter and plump waving hands. By the time it was all over, she had won an enduring place in the affections of all who had seen her.

For most people, Tonga was an unknown land, but after the coronation everyone in Britain knew where it was: a collection of islands on the other side of the world close to the International Date-line.

Queen Salote died in 1965 after reigning for 47 years. Her son, King Taufa'ahau Tupou IV, now rules over the 169 islands and islets — mostly uninhabited.

Aptly named the Friendly Islands by Captain James Cook in the 1700s, Tonga is an archipelago about 1,800 km. north-east of New Zealand in a region of benign temperatures which range from 10 to 30 degrees Centigrade.

The Tongans are believed to be descended from Samoan migrants of thousands of years ago. The early history of the islands is shrouded in myth and based on the ancient kings known as the Tu'i Tonga, who date back to the 10th century. It is said that the dynasty was all-powerful over a vast area of Polynesia.

Evidence of their power remains in stone monuments. The main one is the Ha'amonga which consists of two large upright coral stones about 5 metres high topped by a connecting stone 6 metres long. Weighing around 40 tons, the stones are said to have been erected in the 13th century. The royal burial grounds are known as the *langis*. They contain the remains of an old-time ruling family buried in four-sided mounds. These are faced by huge blocks of coral stone, rising in terraces to a height of 6 metres in places.

Although discovered in the early 17th century by Dutch explorers, Tonga had no

real contact with the outside world for about another 100 years. In 1773, Captain Cook visited the main island of Tongatapu and was so delighted with the warm reception he received that he gave them the name of the Friendly Islands. This was a misnomer because in the first half of the last century the islands' peace was marred by civil wars. These were finally checked by King George Tupou I, who overpowered the unruly factions and gathered all the power into his own hands.

Tonga's Creator

King George had been greatly influenced by English Wesleyan missionaries and was baptised in 1831 during the years of unrest. He was proclaimed king of all the islands in 1845 and reigned for nearly 50 years until his death at the age of 96 in 1893.

He was justifiably regarded as the creator of modern Tonga for, although his rule was absolute, he was determined to give his people a constitution based on the English model.

He limited the powers of local chiefs and gave the islanders the right to own land. Even today, a Tongan boy is entitled, on his 16th birthday, to rent from the government three hectares of bushland and a village site

of about half a hectare. With the population growing by more than two per cent a year there is a growing shortage of land.

King George I also set up a parliament of chiefs and introduced a pattern of democracy which remains. His son, King George II, strengthened the ties with Britain. During his reign, a treaty of friendship with Britain was signed. This led to the islands becoming a British protectorate in 1900.

However, 1970 was a most important date in Tongan history. It was then that independence was granted and the island kingdom became a full member of the British Commonwealth.

It was a year of unforgettable celebration, highlighted by a visit by the Queen, Prince Philip and Princess Anne. On Tonga's main island of Nuku'alofa, which is only 29 km long and 14 km wide, the villagers killed 1,368 sucking pigs and hundreds of chickens for a great feast. Vast quantities of coconut milk were also prepared.

The feast was held in an open park where a special dais was built for the British and Tongan royalty. The Queen sat on the floor on a mat, her legs tucked sideways, surrounded by the rest of the group.

Away from the dais were avenues of posts thatched over with palm leaves for 1,500 other guests. In Tonga commoners

If the waiting crowds were prepared to brave the rain, then so too was Queen Salote. It was a gesture which won the hearts of the whole British nation.



TONGATAPU GROUP



Fonua'elei
Toku

VAVA'U GROUP

Late

'Uta
Vava'u
Hunga
Kapa
VAVA'U GROUP

Kao
Tofua

KOTU GROUP

HA'APAI GROUP

Fonuafo'ou

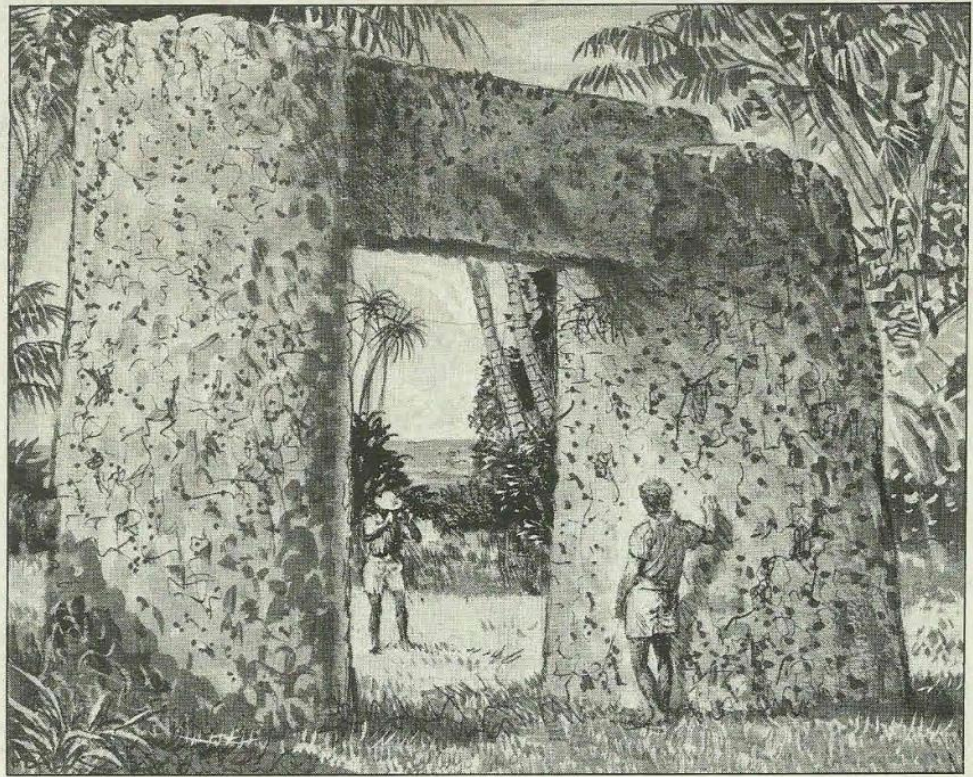
Nomuka Group

OTU TOLU GROUP

TONGATAPU GROUP

0 50 kms
0 30 miles

The kingdom of Tonga is composed of more than 150 islands and is situated in the South Pacific. Our map shows some of the larger islands in the group.



Illustrated by Clive Upton

must never eat with royalty.

It is the custom that visitors are always invited to attend a feast, which includes sucking pigs and other food cooked in underground ovens. Every January there is an annual singing contest presided over by the king, and during Easter magnificent choral singing is featured in the churches.

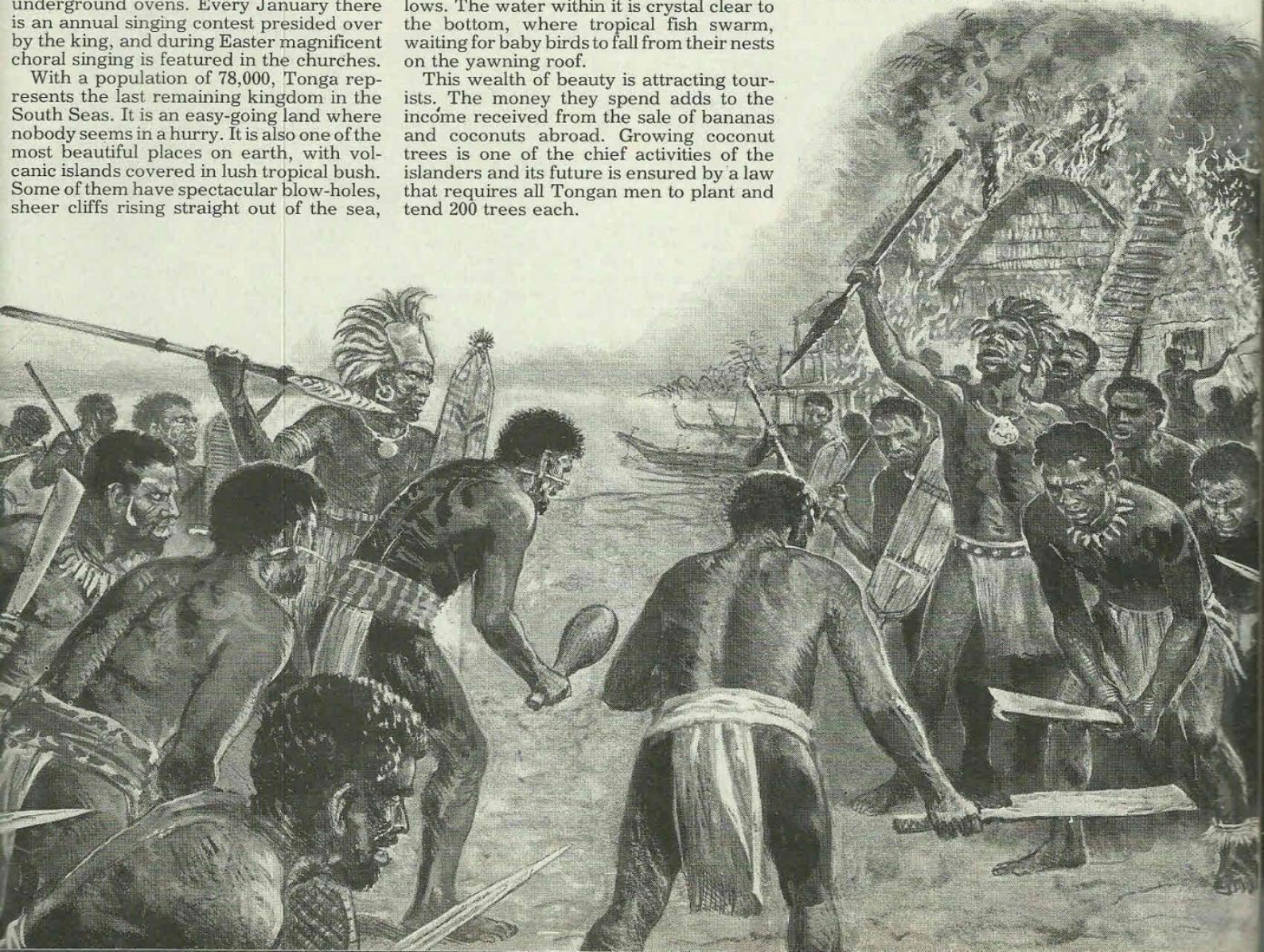
With a population of 78,000, Tonga represents the last remaining kingdom in the South Seas. It is an easy-going land where nobody seems in a hurry. It is also one of the most beautiful places on earth, with volcanic islands covered in lush tropical bush. Some of them have spectacular blow-holes, sheer cliffs rising straight out of the sea,

arching beaches and lagoons.

The sea has carved on one island an enormous cave where thousands of tiny birds live. It is called the Cave of the Swallows. The water within it is crystal clear to the bottom, where tropical fish swarm, waiting for baby birds to fall from their nests on the yawning roof.

This wealth of beauty is attracting tourists. The money they spend adds to the income received from the sale of bananas and coconuts abroad. Growing coconut trees is one of the chief activities of the islanders and its future is ensured by a law that requires all Tongan men to plant and tend 200 trees each.

This enormous monument on Tonga is said to have been erected in the 13th century. It was Captain Cook who gave the islands the title 'Friendly', a name they did not live up to when civil war broke out among the natives.



INSIDE — THREE GREAT NEW SERIES

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LOOK AND LEARN

No. 894, 10th MARCH, 1979. EVERY MONDAY. PRICE 20p.

**KODAK CAMERA
COMPETITION RESULT**

See page 14

**THE HILARIOUS ADVENTURES OF
THREE MEN IN A BOAT**

PART ONE OF A NEW PICTURE STORY — INSIDE



INSIDE STORY

The Craft They Cut In Half

Seaspeed's Super-4 hovercraft started life a good deal smaller than it is now

HOW do you make the largest hovercraft in the world? Simple — you take an existing one and stretch it.

This is exactly what happened to the Seaspeed's SR N4 hovercraft *The Princess Anne*. After tens of thousands of crossings between northern France and the Kent coast, it was felt that she was just not big enough: too many people and cars had to be turned away because of the craft's limited capacity.

It was a case for major surgery. Back she went to the original makers in the Isle of Wight. There she was cut in half and the bow and stern sections moved apart. The

17-metre gap was filled by a new centre section with dramatic results. Seating capacity went up over 60 per cent to 416; car capacity was doubled. At a stroke, a completely new craft had been created.

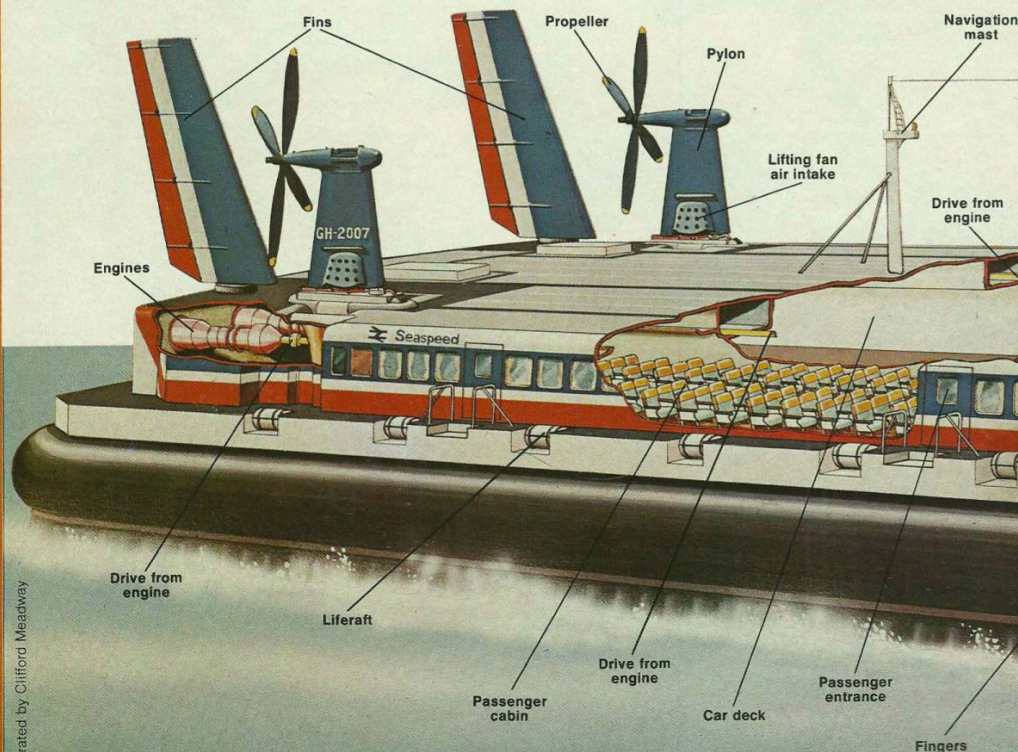
But the most sensational improvements were found in handling. The longer craft, now called the Super-4, could cope far better with the rough, tough weather conditions of the Channel. Cruising speed increased to a maximum of 65 knots — more than the legal road speed limit in Britain. And the passengers found they had a much more comfortable ride.



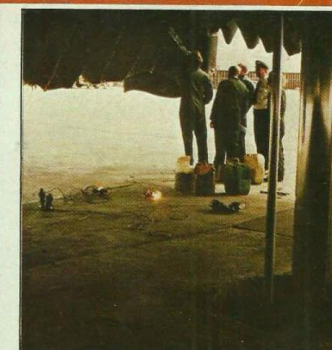
The view from the control cabin.

Vital Statistics

Overall length	56.4 m
Overall beam	28.0 m
Overall height	11.4 m
Air cushion depth	3.0 m
Max. operating weight	300 tons
Disposable load	114 tons
Fuel load	18 tons
Fuel consumption	4.2 tons per hour (kerosene)
Speed (calm water)	65 knots
Passenger capacity	416
Car capacity	55
Range	150 nautical miles max.



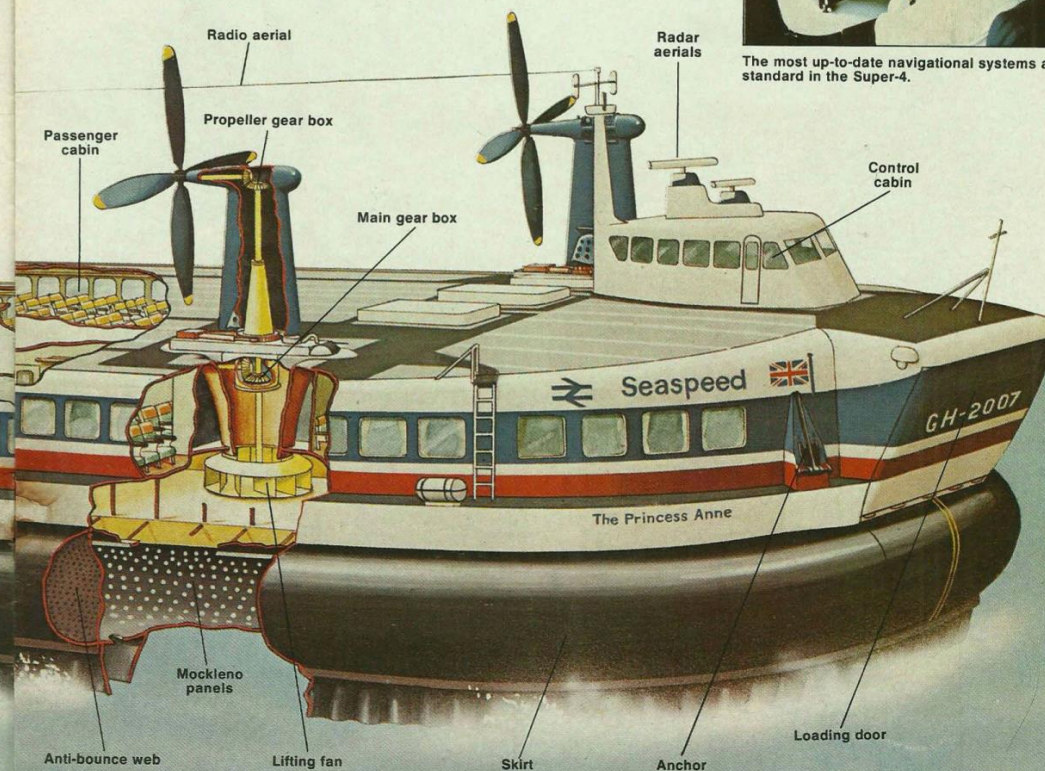
Passenger capacity on the new hovercraft is now 416, and special new terminals had to be built to accommodate the increase. Inset: the "roll on, roll off" arrangement means that the car deck can be cleared within minutes of arrival.

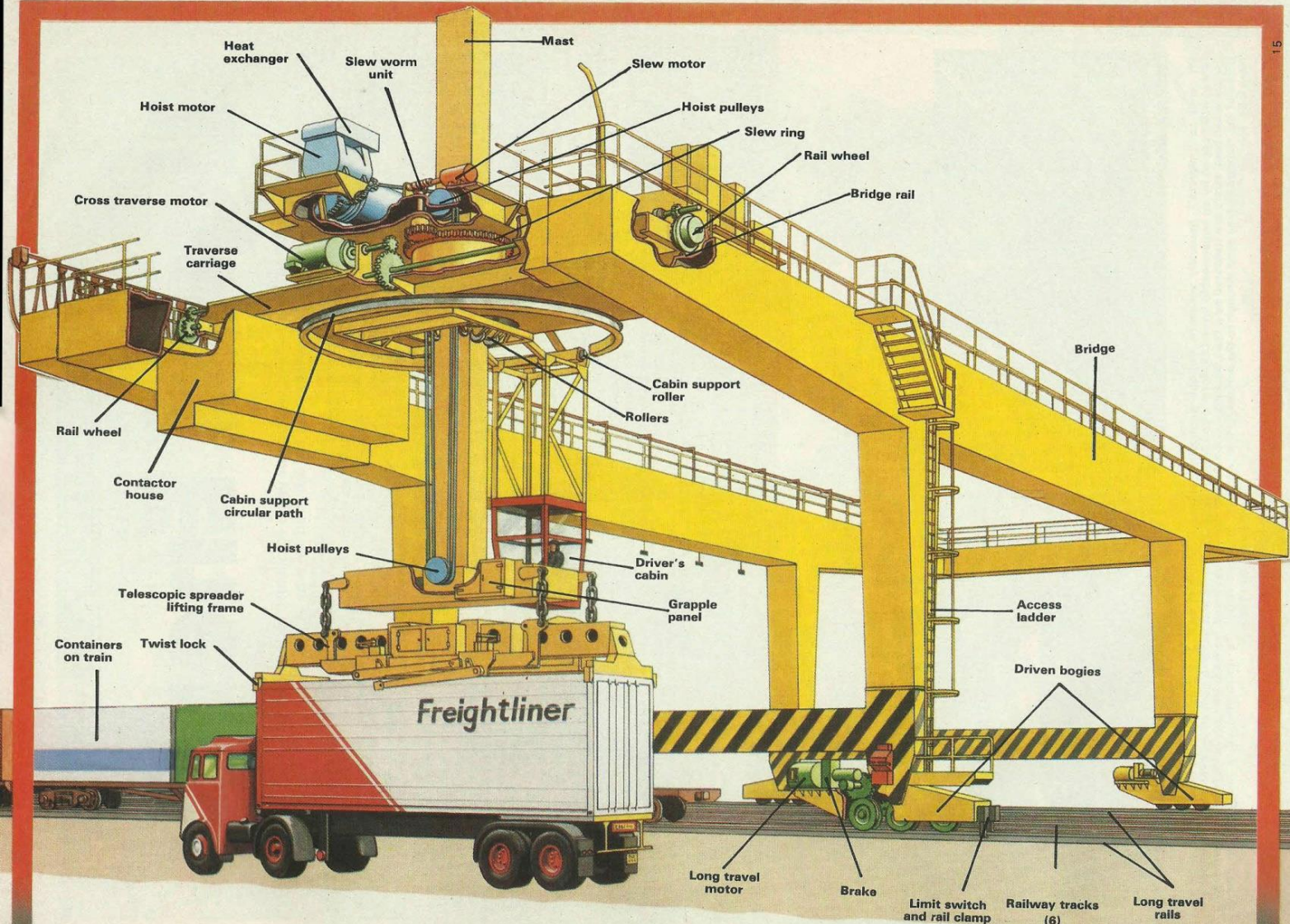


A new, advanced skirt system means an improvement in economy and comfort.



The most up-to-date navigational systems are standard in the Super-4.





INSIDE STORY

The Crane That Takes The Strain

Giant mobile cranes are revolutionising the way freight is moved from one spot to another

Illustrated by Clifford Meadway

OVER the last ten years, a quiet revolution has taken place within Britain's docks and freight yards. Gone are the days when dockers were forced to queue at 7 a.m. in the hope that there might be work that day; now many harbours are oases of calm, a testimony to the efficiency of the change that swept the industry.

The new technique was called "containerisation". This seemingly complicated word has a simple explanation: instead of a manufacturer loading his goods on to a lorry at his factory, from where they would be taken to the docks to be loaded on to ships by dockers and unloaded again at the other side, all he does is to order a "container".

A container is a large steel box which comes in a range of standard sizes. It can be sealed from the moment it leaves the factory to the moment it reaches its destination.

The advantage of this system is that the possibility of theft and damage is reduced; perhaps most important of all, however, is that it is quicker. Instead of taking several men and many hours to unload and reload a lorry, train or ship, huge container-handling cranes can switch the container from one means of transport to the other in just a few minutes. Working flat-out, one of these cranes can handle up to 360 containers a day—and that is a dramatic improvement on the time it used to take to handle a similar amount of traditional freight.

Let us take a look at one of these powerful monsters at work.

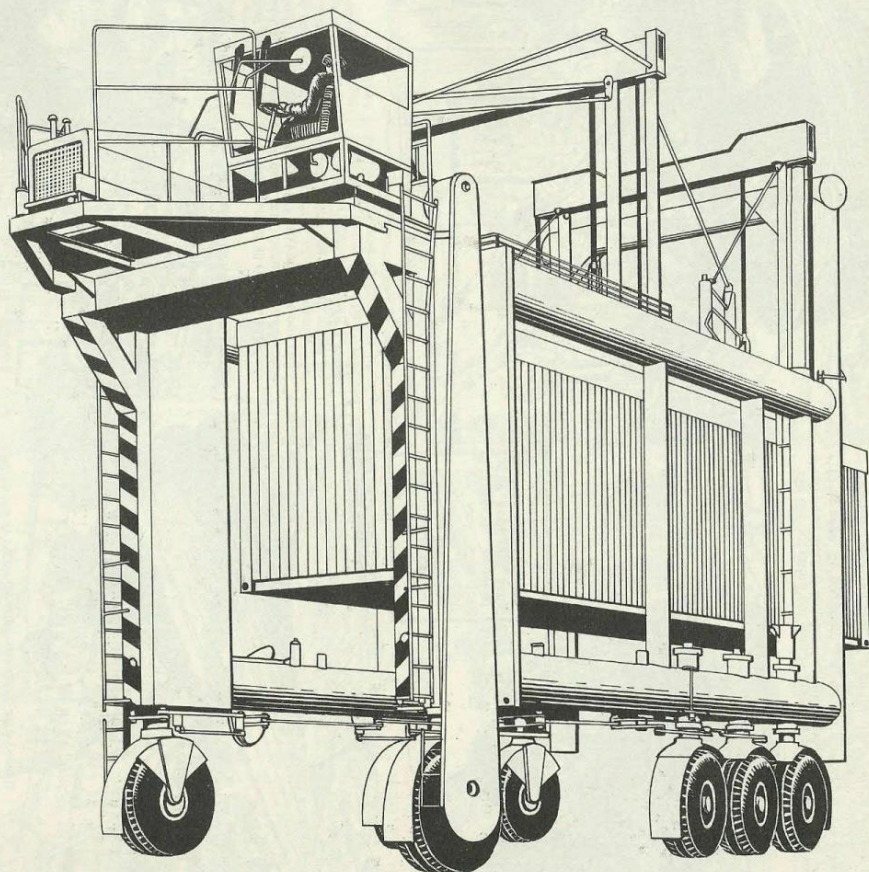
It is an impressive sight. The crane is an Arrol Goliath 2-6-3; the numbers indicate that it can operate over two roadways, six railway tracks and three storage roads.

The Goliath's legs rest on rails which allow the entire piece of equipment to move along the length of a train or a line of trucks. Then the driver's cabin and the grappling assembly (which holds the container) can move sideways across the length of roads, railways and storage areas.

The grappling assembly can rotate through almost a complete circle, and it can also tilt to allow a container to be lifted off a lorry parked on an incline. The crane has been described as being like "a mobile funfair". Certainly, when you see one of these "creatures", with the grappling hooks revolving while it moves both sideways and lengthways along a track, it does remind you of nothing less than an "octopus" at the fair!

Power for these giant cranes comes from a large electrical condenser system. This feeds the controls in the driver's cabin. These only light up when all the lifting connections are perfectly secure.

Suspended high up in his cabin, the driver has a good all-round view and radio connections to the yard office and to the foreman on the ground. In the case of an emergency, a special harness allows the driver to throw himself out of the window—it will slow him down, like a parachute, before he hits the ground!



This Clark eight-wheel straddle carrier is more mobile than the Arrol rail-based crane. Powered by an eight-cylinder diesel engine, it can stack standard 40-foot containers three high.

WIN A HOLIDAY FOR YOU AND YOUR FAMILY!

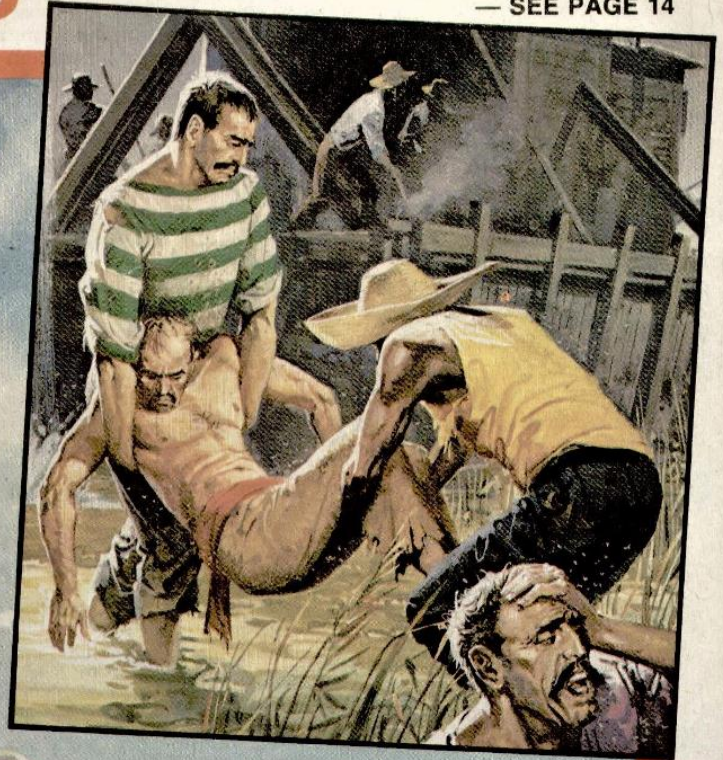
Competition Details Inside

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CONTINENT IN TWO**
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OPERATION DRAKE
THE ADVENTURE OF A LIFETIME
— SEE PAGE 14



Australia 45 cents, New Zealand 45 cents, South Africa 45 cents.

Canada 45 cents, Malaysia \$1.50.

The Train That Leaves The Track

When it reaches a certain speed this train is designed to virtually take off

THE problem of friction affects everything that moves, and engineers have devoted a great deal of time to finding ways of reducing it to a minimum. In the case of trains, the friction of metal wheels pounding along rails has always been a limiting factor which, together with the problem of ensuring that the locomotive and rolling stock do not jump the track, has put a limit on possible maximum speeds.

One way in which the friction problem has been solved is by means of the Magnetic Levitation Train — called "maglev" for short — and several countries have built stretches of experimental track on which to test these unusual passenger transport systems. In Britain, only a short length of scale model track has been constructed, and Japan and West Germany are now the only countries where serious efforts are being made to perfect the maglev system.

In Germany a 31.5 km maglev test track is being built parallel to the main railway line between Haren and Dörpen, while in Japan there is a seven-kilometre track on the island of Kyushu where an experimental "trolley" has reached a speed of 165 km/h, although speeds of double this amount are theoretically possible.

The way maglev works is based on the well-known principle that like poles of magnets repel each other. Applying this principle to a train was at first almost impossible, because magnets strong enough to produce magnetic fields capable of lifting a heavy train were themselves too heavy and massive. Now, however, scientists have designed new, compact high-

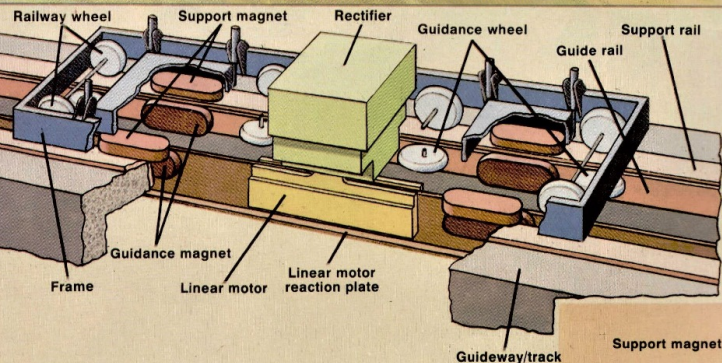
power magnets following a recent breakthrough in low temperature super-conductor technology.

When certain metals are reduced in temperature by immersing them in liquid helium, they offer virtually no resistance to electricity, and they also retain their magnetic properties.

As maglev trains leave or approach stations they use wheels for travelling at the low speeds necessary, but once moving at high speeds the magnetic repulsion between electro-magnets and the special aluminium track lifts the train clear.

Once clear of the track the only drag from friction is caused by its passage through the surrounding air, and efficient streamlining reduces this to a minimum.

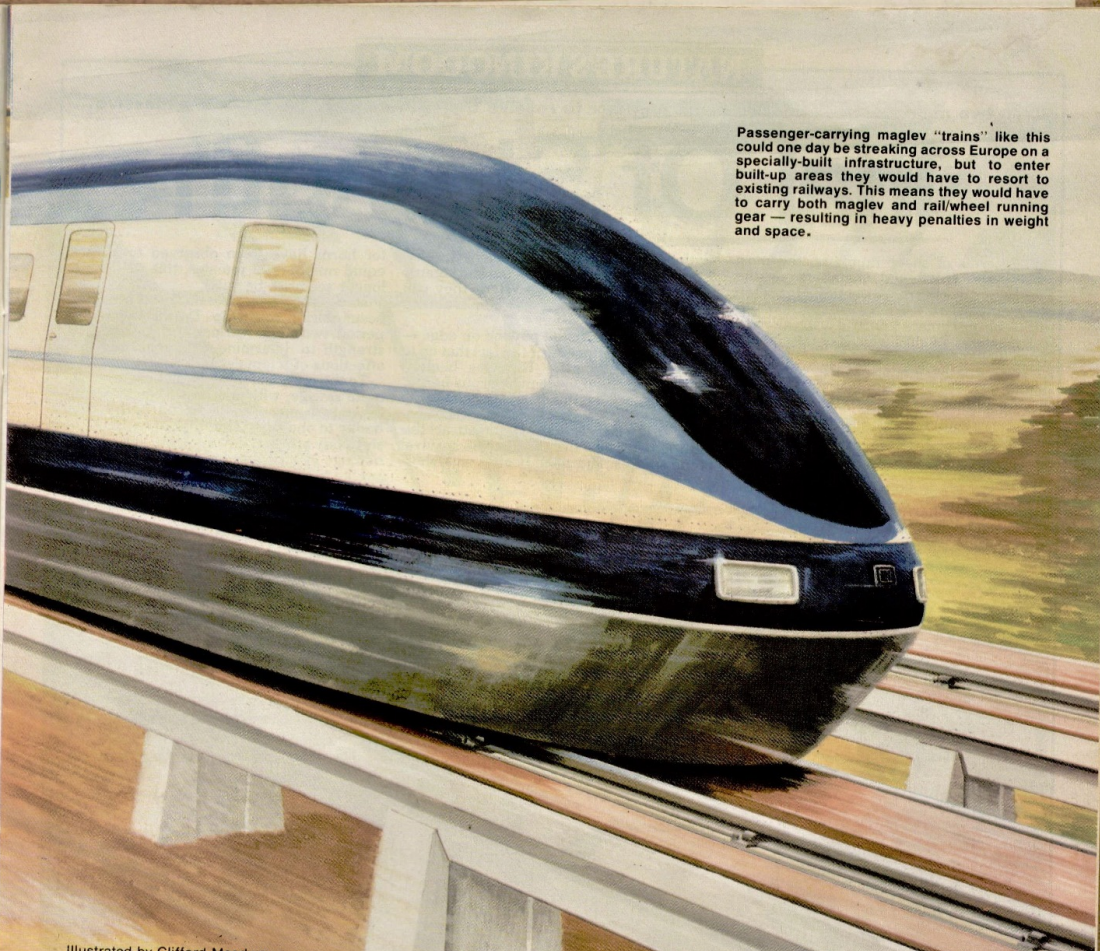
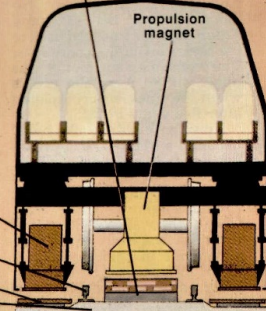
Propulsion is achieved by means of the linear induction motor, a British invention which works in the same way as a conventional electric motor in theory, except that it has no moving parts, and therefore creates no additional friction.



Lowering the support magnets at 120 km/h brings the maglev equipment into play; at the same time the rail wheels are raised. Forward drive is achieved by linear motor in both cases.

Separate electromagnets are used for lift and drive. The linear motor — which can be used in conjunction with existing railway technology — has no moving parts.

Windings for levitation and side guidance



Passenger-carrying maglev "trains" like this could one day be streaking across Europe on a specially-built infrastructure, but to enter built-up areas they would have to resort to existing railways. This means they would have to carry both maglev and rail/wheel running gear — resulting in heavy penalties in weight and space.

Illustrated by Clifford Meadway



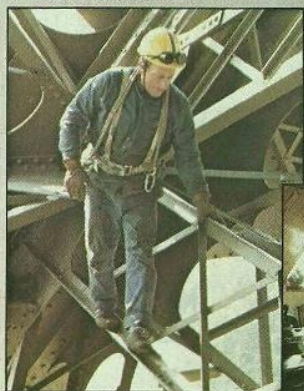
To keep costs low, aircraft components were used to build Japan Airlines' HSST01 prototype maglev vehicle. High-speed trials began in January, 1977, on a 1.3 km test track near Tokyo; levitation is by controlled magnetic attraction.

Transrapid 04 has carried research engineers at 258 km/h on its 2.4 km test track at Allach near Munich. Originally the track was built to test both maglev and airlev vehicles.

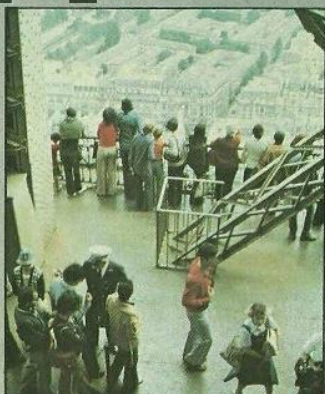
Will Time Topple The Tower?



Dish aerials on the Tower bring clear TV pictures to the people of Paris.



To keep rust at bay, the tower receives a new coat of paint every seven years.



From the viewing galleries on the higher levels, visitors can see for over 75 kilometres in every direction.



Gustave Eiffel's flat on the tower's third level.

The Eiffel Tower is in danger of being sold for scrap. Corrosion, together with enormous running costs, have placed Paris's famous landmark in jeopardy

WHEN asked to say from where one got the best view of the Eiffel Tower, a somewhat cynical Frenchman is reputed to have remarked, "On the Tower itself!" The point of his strange answer was that that was the only place in Paris from which it could not be seen.

Probably one of the world's best known landmarks, the Eiffel Tower can be seen by ten million people living within an 80 km radius of it — when the weather is clear. Named after its designer, Gustave Eiffel, the tower was built for the great Paris Exhibition of 1889, to mark the centenary of the French Revolution.

Eiffel was one of the most famous engineers of his day. His design for the tower was chosen from 18 others short-listed out of a total of 700 which had been entered in response to an invitation by the French government to submit ideas.

Work on the tower began on 26th January, 1887, and it was completed exactly two years, two months and two days later. Before giving it the name of its designer, the French called it simply *La Tour de Trois Cents Mètres* — the 300-metre tower. But as soon as it began to rise above the skyline it came in for a good deal of seething criticism. "Our beautiful city is being besmirched by that ugly pile of iron," they said. Some protesters took to showing their displeasure by making long detours so that they did not have to look at it.

Despite the protests, however, the work went on, and as its graceful shape reached its ultimate height of

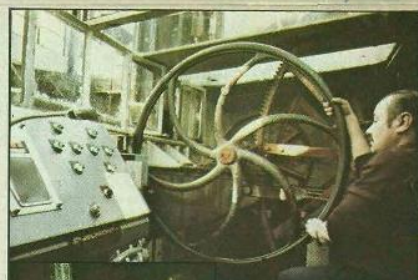
300 metres people began to realise that Gustave Eiffel had produced something which rivalled any of the Seven Wonders of the ancient world. Today, 90 years later, few Frenchmen would disagree that it has become the symbol of their capital city.

In all, just over 7,500 tons of cast iron went into the construction of the tower, which remained the world's tallest structure until 1929, when the Chrysler Building in New York topped it at 318 metres.

The actual construction of the Eiffel Tower was a remarkable engineering achievement for the period: however, despite the obvious dangers of working at heights far greater than anything previously attempted, not a single workman was killed thanks to stringent safety precautions.

Fifteen thousand iron girders were used, held in place by 7,000,000 threaded rods, and 2,500,000 bolts. The bolts were all hand-made, and as each one had to be fitted in place while white hot, portable furnaces were raised by cranes to enable this to be done. The greatest care was taken during construction. Any section which did not meet the precise measurements worked out by Eiffel was discarded. Even today the Eiffel Tower does not sway more than 10 cm at the top, and then only in winds of hurricane force.

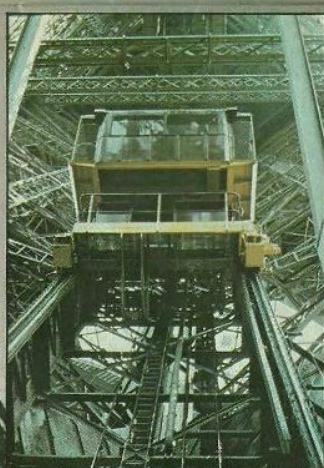
Like all iron structures, the Eiffel Tower needs to be kept painted to protect the iron from rust, and every seven years a small army of workmen have to slap on 50 tons of paint — a job which can take up to two months.



From here, the tower's elevators are controlled.



Oiling the elevator's cranks. The elevator pistons (below) are 18 metres high.



A group of sightseers take the giddy ride to the top.



KODAK CAMERA COMPETITION RESULTS —INSIDE **LOOK AND LEARN**

Australia 45 cents, New Zealand 45 cents

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WHO WILL BECOME THIS YEAR'S

KINGS OF THE RIVER?

SEE 'IN THE NEWS' ON PAGE 14

No. 950, 5th APRIL, 1980
EVERY MONDAY PRICE 30p

SOLDIERS OF FORTUNE

AN EXCITING NEW COLOUR SERIES BEGINS THIS WEEK



The House With All The Answers

Here's a self-sufficient dream home designed to solve the problem of the world's dwindling energy reserves

A HOUSE that need not use mains electricity, coal or gas — one that even provides its own water. Are such schemes impossible dreams — or are they feasible solutions to the problem of energy shortages?

It is now a matter of scientific fact that if the world continues to consume energy at its present rate, reserves of gas and fuel will be exhausted within 75 years. Alternative sources of energy must be found — or else man will perish, just as dinosaurs did millions of years ago.

Once nuclear energy was vaunted as the solution to the energy problem. Today, however, many people are frightened by the level of supervision necessary to prevent a leak of potentially lethal radiation. There is also the problem of disposing of nuclear waste, which will be a dangerous legacy for generations to come.

The "Doomwatchers" say that man is threatened by nuclear disaster in one form or another, unless he can find an alternative, non-nuclear source of energy; either from an incident such as that which occurred at Three Mile Island in the USA last year, or from a nuclear war triggered off by countries vying with each other for the ever-shortening

reserves of oil and gas.

With this in mind, scientists have begun looking at ways of exploiting Earth's other natural resources. We already have hydro-electric power giving us power from the rivers and tides. But what of the other elements — the sun, and the wind?

The illustration shows how a house which is almost entirely self-sufficient in energy might be built; a house that uses the wind to provide its electricity, solar radiation to heat its rooms, rainwater for drinking and bathing, and natural waste to produce methane gas for cooking. In such a house, fuel bills could be drastically reduced, if not entirely eliminated. The owner would be independent of centralised energy suppliers and therefore capable of surviving a disruption of "mains" supplies of energy.

Such a house would need to be south-facing in order to maximise the amount of solar radiation falling on the roof, which would be covered with solar panels. The solar panels would use the sun's radiation to heat rainwater falling on the roof and collected in tanks. Once filtered, this rainwater could also be used for drinking, cooking and bathing.

One problem with solar heating,

however, is that the sun produces the most energy during the summer months — when the demand for heating is at its lowest. Either a means of storing the heat produced in the summer must be found, or we must look for another method of generating power during the winter.

The house shown here has provision for both requirements. Underneath it a heat store — a bed of rocks — has been built to hold the heat generated when it is not immediately required.

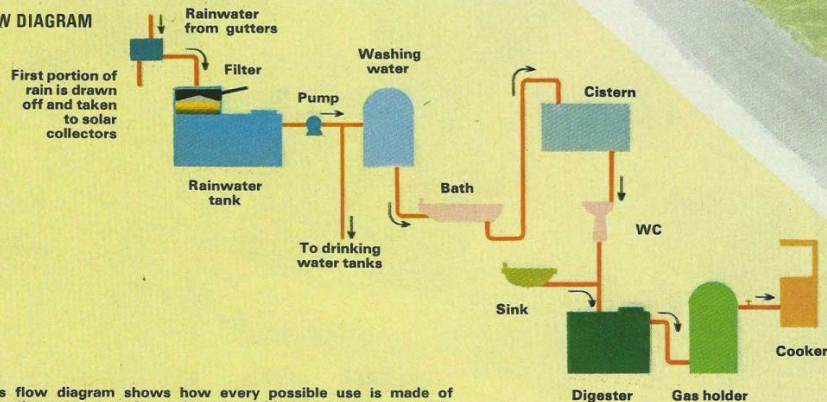
Then a wind-powered generator produces electricity as a back-up should the sun refuse to shine. Unlike solar energy, the wind is at its strongest when the demand for electricity is at its highest — during winter nights.

Finally, the house becomes virtually energy-self-supporting with the installation of a "digester". This device converts household waste and human refuse to methane gas which can then be used for cooking.

Such houses can be built, and have been built in the USA. In Britain, however, the cost may discourage potential purchasers, and this has to be weighed against the fuel costs saved. But we need to investigate the possibilities of such schemes — before it is too late.

1. Conservatory.
2. Gutter for collecting rainwater.
3. Filter.
4. Drinking water (converted from rainwater).
5. Rock, sand or earth heat-storage bed. (Surplus electricity is used to heat coils in the bed. Surplus hot water is stored in a tank in the bed.)
6. Digester.
7. Methane gas-holder.
8. Water disposal unit in sink.
9. Header containing drinking water.
10. Solar panels.
11. Water from bath, etc., recycled to flush WC.
12. Pump.
13. Water supply.
14. Cold-water tank.
15. Pipe to solar tank.
16. Hot water from solar collectors.
17. Hot water to hot-water tank.
18. Hot-water tank.
19. Overflow pipe.
20. Solar storage tank.
21. Circulator pump.
22. Return pipe to solar collectors.
23. Rainwater.
24. Generator.
25. Windmill.

FLOW DIAGRAM



This flow diagram shows how every possible use is made of natural resources, such as rainwater and human waste, to provide the most economic form of energy consumption.



Using the sun, wind, rain and natural human waste, this house should in theory be capable of supplying all the energy needs of its occupants.

ADVENTURE-SCIENCE-NATURE-PEOPLE-PLACES **LOOK AND LEARN**

Australia 45 cents, New Zealand 45 cents,

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EVERY MONDAY PRICE 30p

Speedbird Is Cleared For Take-Off

BEHIND THE SCENES AT BRITISH AIRWAYS — THIS WEEK'S INSIDE STORY
on PAGE 15



Speedbird Is Cleared For Take-Off

In this special feature we take a behind-the-scenes look at the way in which a Lockheed TriStar 500, one of British Airways' newest planes, is prepared for its long flight to the Far East



Written and illustrated by Wilf Hardy

"SPEEDBIRD 033 is cleared to take off; surface wind 320°, five knots." These words, from the control tower at London Heathrow Airport, give permission for British Airways Flight Number BA 033 to begin its journey to Bombay, Kuala Lumpur and Singapore.

The aircraft, one of the newest additions to the world's largest international airline, accelerates down the runway and lifts smoothly and quietly into the sky. The time is 1545 and BA 033 has departed on schedule, operated by a Lockheed TriStar 500. This is the long-range version of the design, capable of a non-stop 5,000 nautical miles, a distance known to the airlines as "long haul". All civil aircraft are identified by their registration letters and this one is known as G-BFCB — or "Charlie Bravo", after its last two letters in the phonetic alphabet. Its seating is arranged to accommodate 24 first class and 211 economy class passengers, with baggage and cargo carried below the cabin floor.

The preparation of the aircraft for flight started some hours before and has involved the skills of many experts on the parking stand at the terminal and behind the scenes.

Charlie Bravo is maintained in

perfect technical order by British Airways' Heathrow engineering base, the largest in Europe. The TriStar 500, powered by three Rolls-Royce RB211-524 B Turbopan engines, is one of the most advanced designs in the world and, like any large, complex aircraft, requires extensive expert care at regular intervals.

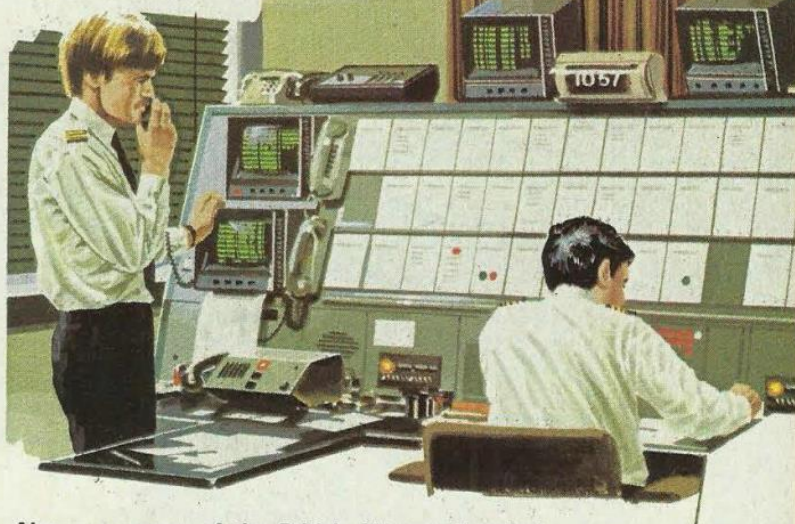
Week-long Check

This engineering care ranges from the half-hour "PDI" (Pre-Departure Inspection), before every flight, to, for example, a Check 5, which is carried out every 3,000 flying hours and takes up to seven days. And even this is not the most comprehensive overhaul in the manual.

Two hours before its departure time Charlie Bravo has been towed to Stand Juliet 15 at Terminal 3, the long-haul terminal. There it is the responsibility of British Airways' Terminal Control, which supervises all services necessary for its punctual departure.

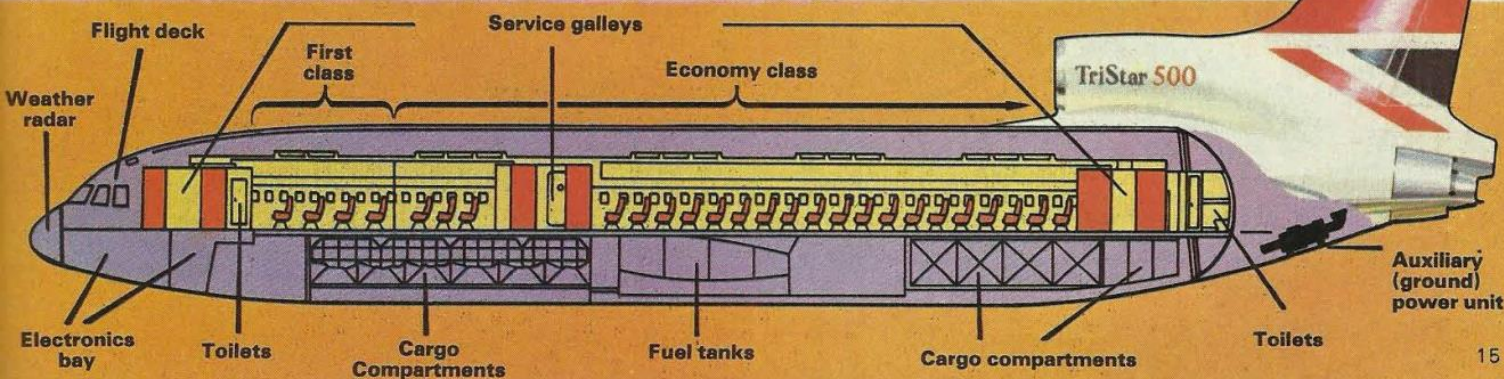
The man at the centre of the preparation is the "Redcap", with his walkie-talkie and red-top vehicle. He is in contact with everyone involved in BA 033's departure.

Above: the key man in preparing an airliner for flight is the "Redcap", whose job is to be everywhere at once around the aircraft to ensure that all is going according to plan for a departure on schedule. Besides his red cap he can be recognised by the red-topped vehicle he drives.

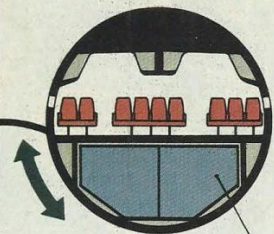


Above: a corner of the British Airways Terminal Control, Terminal 3, Heathrow. The officers on duty must ensure that every flight arriving or leaving does so efficiently, and they co-ordinate all necessary services by radio or telephone.

Below: the interior of a TriStar 500, long-haul sister of the larger TriStar 100.



CONTINUED ON PAGE 18



Above: a cross-section of the fuselage, showing how the LD3 passenger baggage containers are shaped to fit neatly in pairs across the cargo hold.

Air intake to centre engine

Cabin service food arrives in standard-size containers which slot under the galley work surfaces until needed.

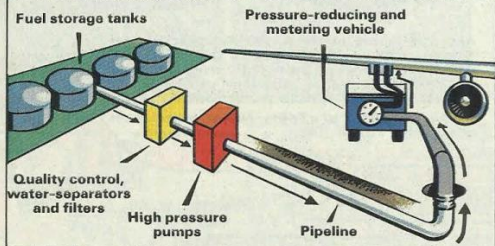
The Cabin Services Centre operates in shifts 24 hours a day, employing 700 people to supply the needs of a world-wide organisation.

Cleaning staff carrying out a final inspection

Conveyor-belt loader moving crew baggage into rear freight hold

Crew bus, having dropped crew at stairs, moves round to deliver their baggage

To give the aircraft its long range, fuel tanks are built into wings and fuselage



The diagram above shows the hydrant fuelling system in simplified form. Fuel is pumped through the pipes at a pressure of 150 lb per sq. in. after rigorous checks on its purity. There is a twin pressure-fuelling point on the underside of each wing, from which fuel can be directed to individual tanks. Fuel can, of course, be pumped out in the same way when the aircraft is due for maintenance work.

Rolls-Royce RB 211-524 B Turbopan

Forward cargo hold takes four pallets (right), 12 LD3 containers (top left). Central hold takes six LD3 containers

Doors slide up and down inside fuselage for entry/exit

Hydraulic loader for cargo. Loads move easily in and out on roller bearings.

Catering vehicle delivering food to first class service galley. It is raised hydraulically to the height of the door.

Ground power unit supply. This provides electrical power until the aircraft's engines are started. Aircraft's own auxiliary power unit is not started where other units are available.

The cabin crew check their supplies against the lists drawn up for the flight. These will include not only the prepared foods but fresh fruit, cheese and wine. Films will be shown to help make the long flight pleasant.

Stairs used by staff preparing aircraft for flight. Passengers will walk down the jetties direct from the lounge to the cabin

Ducts to cabin air-conditioning system. The air is completely changed every three minutes

Flight engineer

First officer

Captain

Terminal building

British Airways Flight BA 033 being prepared for departure — the Radcap and his vehicle can be seen at lower left. This flight is just one routine operation among hundreds carried out each day by a massive organisation which must also be good at details. There may be incoming or outgoing passengers who need special care — for instance, handicapped people or young children travelling alone. In addition to the services shown, toilet-servicing and fresh water vehicles will visit the aircraft, together with other specialised vehicles for handling cargo. Small items of high value or importance will be brought in a security vehicle and numerous other small vans will bring specialists to attend to details in their own departments.



The flight crew have established their flight plan beforehand and it has been relayed to control centres along the route. Computers supply facts based on payload, fuel and weather to help the final decision.

HARDY

First to arrive are the cleaning staff, who will ensure that the galleys, seats, carpets and toilets are spotlessly clean. Covers are laid to protect the carpets while other cleaning is carried out.

The technical ground crew follow on, to carry out the PDI. A visible sign of their presence is the bright winking of the navigation and anti-collision lights.

Next come the special catering vehicles from the British Airways Cabin Services Centre, a huge complex which provides not only food, but also blankets and pillows, baby care, duty-free goods, tobacco and drinks, children's books and games, cutlery, glass and linen, magazines, stationery and first aid equipment.

Containers of mail arrive next, and cargo-loading begins under supervision of the head loader. The big containers, designed to fit snugly into the TriStar hold, are positioned on rollers and hoisted up on hydraulic lifting platforms.

At the same time, fuelling begins. BA 033 will take on (or "uplift", in airline jargon) 25,000 gallons of Jet A-1 aviation kerosene, weighing 85 tons. The thirst of the wide-bodied "Jumbo" airliners has meant that in some areas the familiar giant tanker lorry has been replaced by an underground hydrant system. In this the fuel is pumped from storage tanks on the edge of the airport direct to the parking stands at the terminal. A small fuelling vehicle is connected to the hydrant and to the aircraft and performs two functions: it reduces the pressure of the flowing fuel and it precisely monitors how much is being supplied.

It is vital that fuel and cargo are correctly positioned. Each is carefully checked as it goes aboard — fuel by an oil company expert and cargo against a loading diagram prepared for each flight.

One hour before take-off the crew bus brings the flight crew (captain, first officer and engineer officer) and the cabin crew (cabin service officer, first steward, purser, stewards and stewardesses) — 12 people in all. The flight engineer conducts his own "walk-round" PDI, and fuel and safety checks; then the flight crew begin their long pre-flight check-lists. The cabin crew put on their flight uniforms and check catering supplies, cabin service items and menus.

Flight announcements to BA 033's passengers have been made at regular intervals and they are



assembling in the lounge nearest the aircraft. About 35 minutes before departure the last calls are made and the baggage, which has been checked in on arrival, is transported to the aircraft in special containers.

BA 033 now begins to receive its passengers aboard. They come from the departure lounge down a movable "finger" jetty positioned snugly against one of Charlie Bravo's doors.

At 15 minutes before departure the Redcap radios for the push-back tug which will be attached to the aircraft's nosewheel leg to manoeuvre the aircraft away from the terminal. A check is now made comparing the passenger list with the number of people who have actually boarded the plane. At the same time the load control officer checks with the head loader that the cargo is correct and properly distributed. Charlie Bravo's captain then signs to indicate his satisfaction and, with the doors closed and checked and the tug in position, all is ready. The flight crew now call the tower for the first time, to request the ground movement controller for permission to start the engines. With this received the push-back com-

Above: the enclosed, movable jetties allow passengers to walk in comfort from the departure lounge directly into the cabin, regardless of the weather. Visual guide marks allow pilot or ground staff to position the aircraft for the jetty.

Right: the low-slung push-back tug designed to fit under any airliner nose.



Above: the familiar "glasshouse" on top of the control tower houses the ground movement and departure controllers who visually, and with radar, supervise all aircraft movement up to the time of take-off and after landing.

Below: G-BFCB is at all times under the watchful eyes of the British Airways world-wide flight operations control centre.



mences. It is usually Number 2 engine, the centre engine, which is started first.

In the capable hands of the air traffic control network, BA 033 takes off, climbs swiftly to cruising height and settles down for the long haul to Bombay. Throughout its flight and return to London it will be monitored by British Airways' Control and Operations Centre, on duty 24 hours a day to ensure the smooth running of services the world over.

(Our thanks to British Airways, British Airports Authority and Shell UK Oil for their help in the preparation of this feature.)



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No. 956, 5th July, 1980
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THE TEST MATCH TRIUMPH THAT COMPLETED

Boycott's Century Of Centuries

SEE PAGE 2

INSIDE STORY

A Tough Test For The Titan

BEFORE a new bus goes on the roads in regular service, it has to undergo a series of rigorous tests to ensure that it will be safe and reliable. Typical of these tests were those undergone by the Leyland Titan.

Now in use with London Transport, and other bus services, the Titan was first made to prove its worth. The trials programme started with special tests on static and mobile rigs on the body structure, suspension, transmission, engine and cooling systems.

Five prototype buses were made. Together, these clocked up 200,000 kilometres of tough driving, including 2,500 kilometres over bone-shaking cobbles. One prototype spent two years in service with London Transport, before going into operational trials with the South Yorkshire Passenger Transport Executive. Another covered over 30,000 kilometres while on test in Birmingham.

These tests proved the efficiency of the structure, suspension, brakes, fuel economy, low internal and external noise levels, and air and

water flow for the heating and ventilating system.

As part of the development programme, which turned the Titan from a designer's drawing to a working bus, the tests were vital in proving the vehicle's efficiency.

The result is a bus that gives its passengers a smooth ride with excellent heating and ventilation, air suspension, minimum roll and pitch and barely noticeable gear-changes by an automatic gearbox.

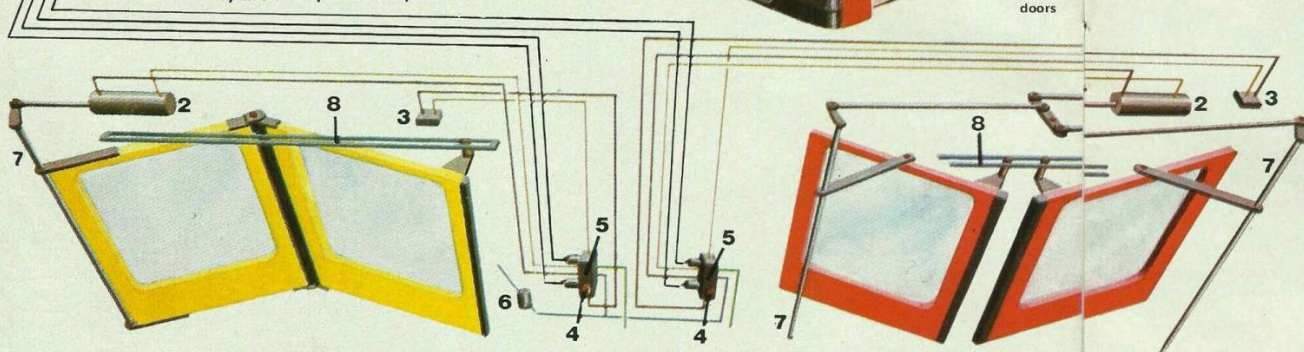
Power is provided by a Leyland TL11 6-cylinder turbo-charged engine (or a Gardner 6LXB as an alternative). A fully-loaded bus can accelerate from 0 to 48 km/hr in 25 seconds. For servicing, the engine can be taken out and put back in ten hours.

For the driver, there is a deep windscreen, power-steering, fully-automatic transmission, and a seat which can easily be adjusted to the best driving position.

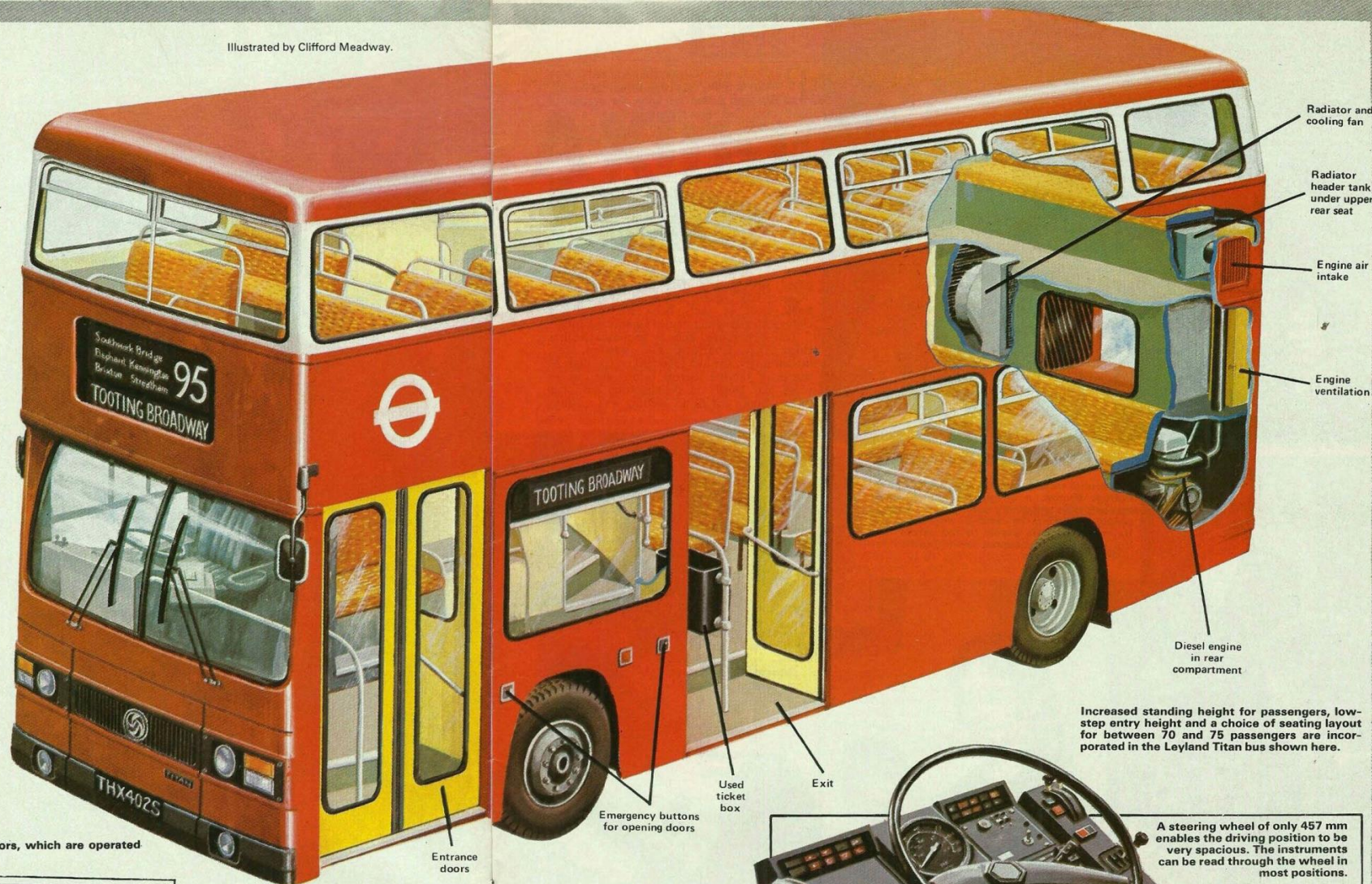
Since their first appearance five years ago, the number of Titans on the road has grown to 200, mostly in London, but some also in other cities.

1. Controls in driver's cab. 2. Actuators. 3. Interior emergency buttons. 4. Exterior emergency buttons. 5. Spool valve assemblies. 6. Pressure regulator valve. 7. Door pillars. 8. Guides and guide rollers. Electrical leads—black. Air supply—blue. Air feed pipes, open—brown, closed—yellow.

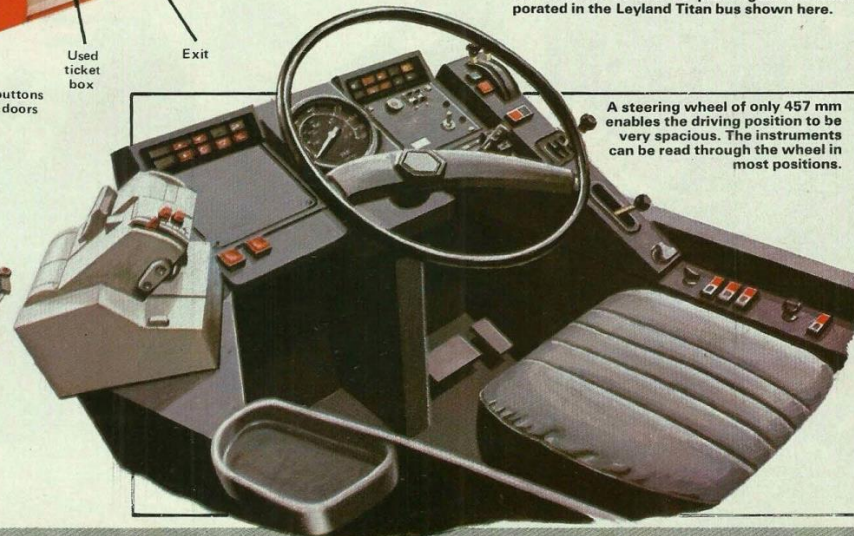
1 Aerial view of the entrance/exit doors, which are operated by an electro-pneumatic system.



Illustrated by Clifford Meadway.



Increased standing height for passengers, low-step entry height and a choice of seating layout for between 70 and 75 passengers are incorporated in the Leyland Titan bus shown here.



Hide~And~Seek Hunter

The Polaris submarines keep a 24-hour watch for the threat of possible attack

DEEP in the waters of the North Sea, the Royal Navy's nuclear submarines stand guard over our shores. Always on patrol in the seas around Britain, they are this nation's nuclear deterrent force. For this purpose, they are equipped with Polaris ballistic missiles, which have nuclear warheads.

Typical of them is HMS *Resolution*, the vessel shown below. Launched in 1960, it carries 16 Polaris missiles and six torpedo tubes. Powered by its nuclear reactor, which creates heat to operate a steam turbine, it can cruise at 25 knots. Its missiles are fired underwater, propelled by two-stage rockets which carry them through the air towards their target up to 4,000 kilometres away.

Because of the size of their engines, crews and missiles, nuclear submarines have to be very large; HMS *Resolution* displaces 7,500 tons and is 140 metres long.

The missiles are over nine metres high and need a great deal of equipment to manage their navigation, fire control and tracking. Much of the rest of the space in the submarine is taken up by the nuclear reactor, which is heavily insulated, and the heat exchanger, which generates the steam to drive the main turbines. Their power is transmitted through reduction gearing to the propeller shaft.

The submarines are capable of remaining at sea for up to 90 days, but 60 days is the normal duration of a patrol. Towards the end of that period, the nervous strain of living so long in a confined space without daylight begins to tell on the crew. Enough food is carried to enable the patrol to be extended if necessary, and endless supplies of air for breathing and fresh water for drinking and other purposes can be obtained from sea water.

Each submarine has two crews. When a submarine returns from a patrol, the crew go on

leave. A second crew starts to get the submarine ready for its next patrol, a task that takes a month. Near the completion of this period, it will receive help from the crew it relieved.

The normal cycle is that while one submarine is at sea, a second is almost ready to begin a patrol, while a third will have just returned from duty at sea. The fourth could be in dock undergoing its regular maintenance, known in the Royal Navy as a refit.

Nuclear submarines are among the latest in a long line of underwater vessels. Their story really begins in the second half of the 16th century, when an Englishman, William Bourne, created the design for a ship to travel under the sea. His plan was for a vessel with an inner hull of greased leather that could be stretched inwards or outwards to expel or admit water between itself and the wooden side of the vessel. Air was taken in through a hollow mast.

Sub With Oars

Cornelius van Drebbel, a Dutch physician, improved the design in 1620. He used an ordinary rowing boat, with the top covered over, and leather to control the amount of water let in. Drebbel also had a device for sucking in fresh air and pumping out stale air. With six oars flapping like fins, he was able to carry passengers down the Thames, with nearly all the boat underwater.

Various other attempts to design a submarine followed. One of them was by Robert Fulton, an American. In 1800, Fulton used his submarine to blow up a hulk in Brest harbour.

Walter Delany, a Chicago engineer, patented a submarine in 1859. In the centre were two steel tanks, one holding water and the other compressed air. By pumping water into or out of the first tank by compressed air, the

buoyancy of the vessel could be adjusted to various depths.

During the American Civil War, John David, a Confederate naval officer, built a submarine for use against the Federal squadron blockading Charleston. Eight men turned the propeller of this craft, which in 1863 successfully sank a Federal warship.

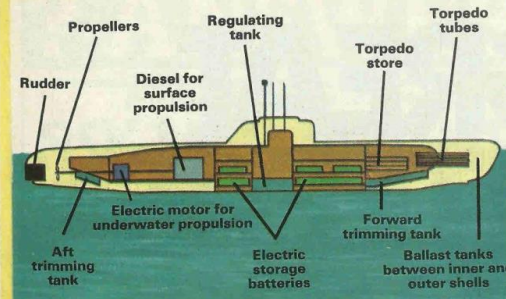
In 1885, a Swede, T. Nordenfeldt, designed and built six submarines driven by electric motors. They dived or surfaced by filling or emptying ballast tanks. John P. Holland built a submarine in 1895, which was propelled by steam on the surface and by electric motors when submerged.

The British Admiralty ordered five Holland submarines in 1900, and from them was developed a submarine which was entirely British in design and construction. It was the first to be fitted with a periscope for observing the surface while submerged. Germany did not build her first submarine until 1906, being the last of the naval powers to adopt this type of warship — though she made wide and deadly use of them in both World Wars.

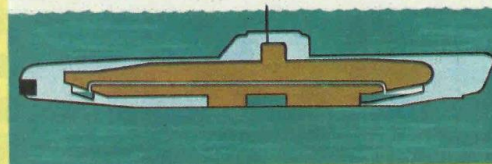
By this time, diesel engines were in general use for propulsion on the surface, battery-driven electric motors being retained for submerged operations.

With these developments, the construction and operation of submarines became standardised. Until the later stages of the Second World War, the submarine was much the same kind of boat as in 1900. The chief improvements were in size, speed and armament.

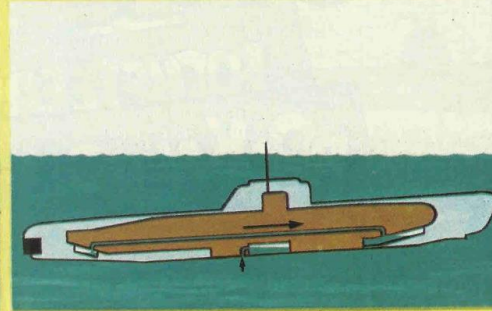
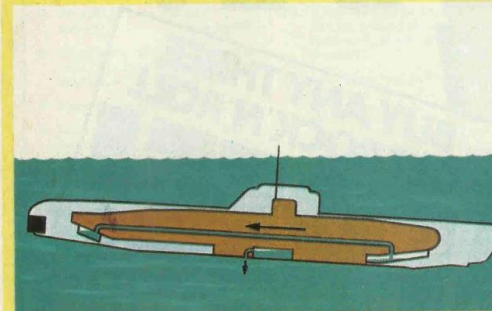
The first nuclear submarine was finished in 1955, and in 1960 one went around the world submerged for the whole time. This facility, aided by their nuclear armament, makes modern submarines vital factors in this and other nations' defensive forces.



The layout of conventional submarines is shown by this German U-boat, class XX1, built between 1944 and 1945. These pictures show how such a boat submerges. On the surface, the ballast tanks are empty.



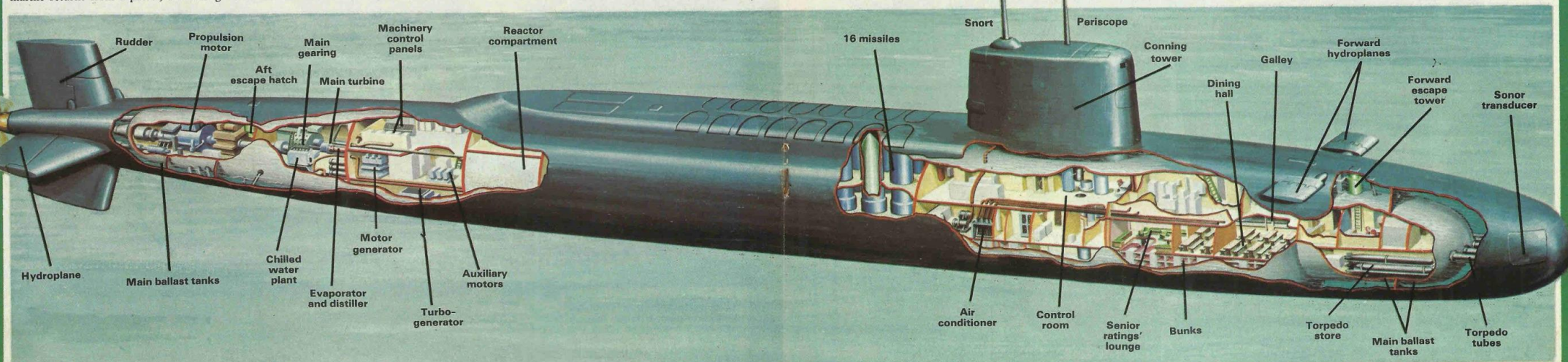
Before diving, water is let into the tanks through lower valves, and the air escapes through upper valves. Water is admitted until the vessel weighs as much as the water it displaces.



The slightest change in weight, fore or aft, causes the boat to alter its position. This is counteracted by pumping water either to the forward or after trimming tanks. The submarine's weight is regulated by the amount of water pumped into, or out of, the tanks. For steering, the craft uses hydroplanes and a rudder.

Illustrated by Clifford Meadway

HMS Resolution One of Britain's four Polaris ballistic missile submarines.



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No. 963, 23rd AUGUST, 1980.

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Alone Against The Atlantic

The single-handed sailors—see page 4

The incredible story of the

Railway Through The Khyber

Page 30

Operation Drake

More news about the great adventure
—inside



INSIDE STORY

The Slow Crawl To Blast-Off!

Huge space vehicles are carried at a snail's pace to their launching pad by a mammoth transporter

TWO years of delays, due to technical and engineering tests, have caused repeated holdups to America's space shuttle project — a system employing recoverable, and therefore, reusable spacecraft. However, the space shuttle now seems set for its maiden voyage in space next February.

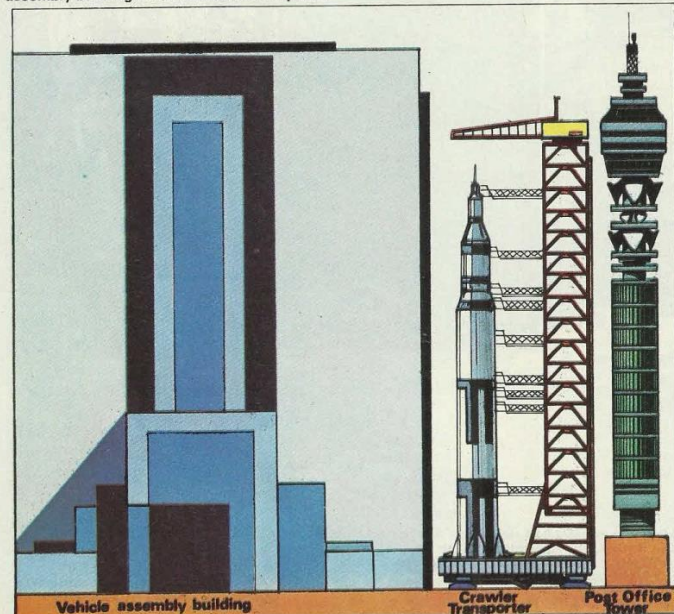
Space craft launched from Cape Kennedy are assembled five kilometres from the launch pad in the Vertical Assembly Building (VAB), which is the largest building in the world. Inside this, four Saturn 5 rockets were assembled simultaneously.

To take the shuttle to its launching pad, the crawler transporter, a tracked vehicle, will be inserted under the mobile launching platform. Bearing its mighty load, the transporter will creep to its destination at a speed of about one-and-a-half kilometres an hour.

The crawler is controlled from two driving cabs at diagonally opposite corners of the vehicle. Movement, levelling and equalising of the load are directed from here, and winds of up to 48 knots blowing on the vertical load can be compensated for.

Each of the four crawler units is driven by four motors. So manoeuvrable are these crawlers in their ability to pivot, that the load can be turned in a crablike movement.

Shown beside London's Post Office Tower for a comparison of their heights, are the vehicle assembly building and the crawler transporter.



Smooth stopping is obtainable with the disc brakes on the drive shafts, which operate automatically if any motor breaks down.

The crawler's two parts, chassis and platform, are carried on steel-link caterpillar tracks like a tank's, but each link weighs about a ton.

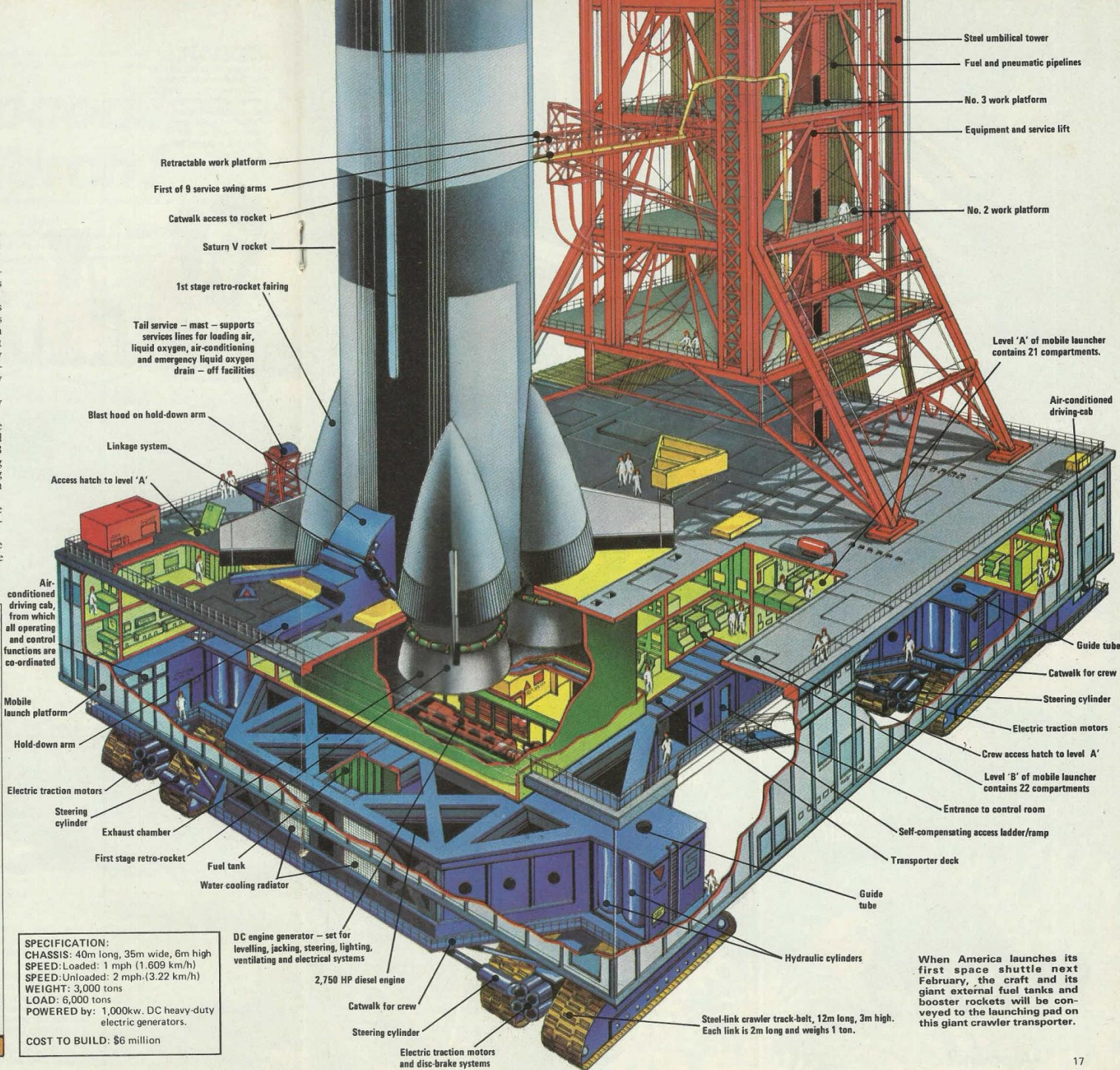
The first time the crawler transporter was used on a full-scale Apollo-Saturn 5 vehicle was when it rolled out a 500F (a full-scale moon landing vehicle) on 25th May, 1966, at Merritt Island at the Kennedy Space Centre, exactly five years after President Kennedy had committed the USA to a manned lunar landing by 1969, which was eventually achieved.

The crawler transporter was subsequently used for all the Apollo missions.

Like the Apollo-Saturn 5 vehicle, the space shuttle and its giant external fuel tanks and booster rockets will be built upright in the VAB on a mobile launching platform. The launching platform will be jacked up on six supporting pedestals and the crawler eased into position for accepting the load.

At the Kennedy Space Centre much of the equipment used for the moon flights was assembled and launched with crawler transporter.

These flights were vital to America's space programme — and just as important will be the launching of the space shuttle next February.



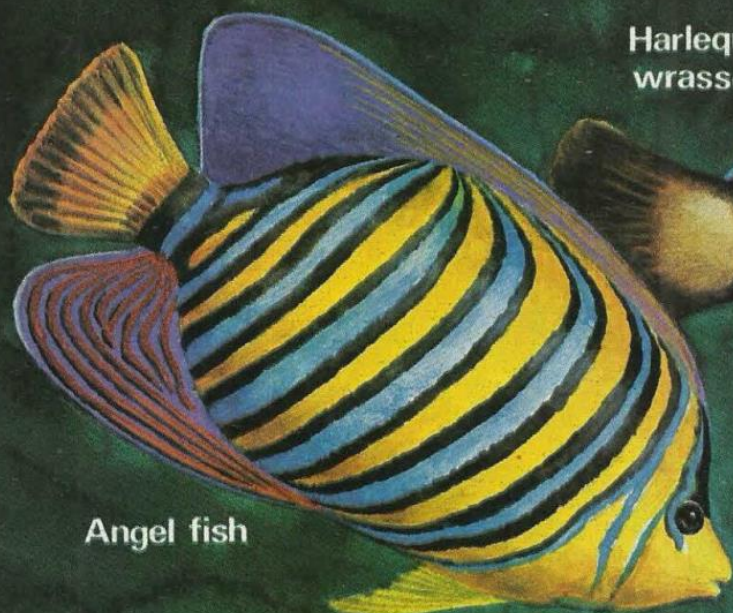
SPECIFICATION:
 CHASSIS: 40m long, 35m wide, 6m high
 SPEED: Loaded: 1 mph (1.609 km/h)
 SPEED: Unloaded: 2 mph (3.22 km/h)
 WEIGHT: 3,000 tons
 LOAD: 6,000 tons
 POWERED by: 1,000kw. DC heavy-duty electric generators.
 COST TO BUILD: \$6 million

When America launches its first space shuttle next February, the craft and its giant external fuel tanks and booster rockets will be conveyed to the launching pad on this giant crawler transporter.

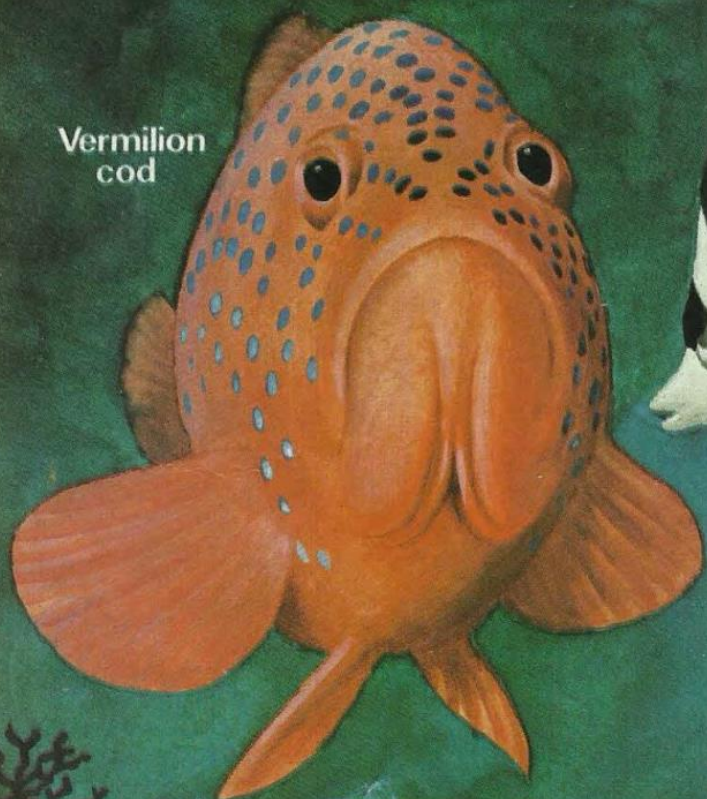
Harlequin
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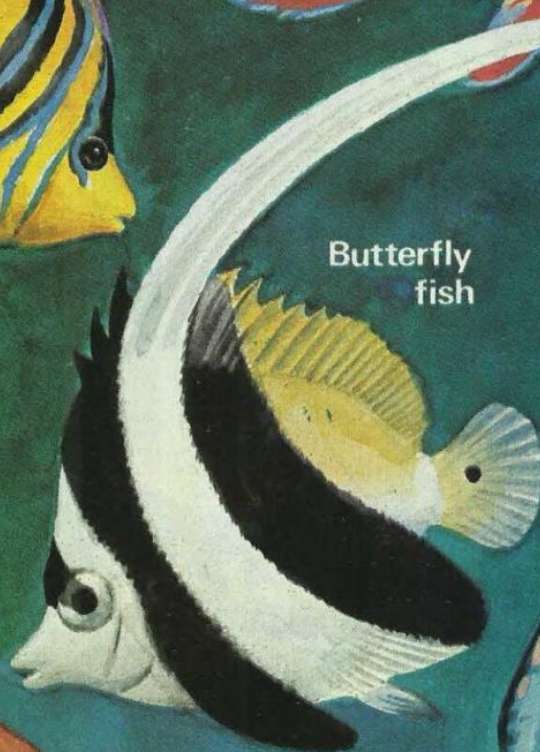
Angel fish



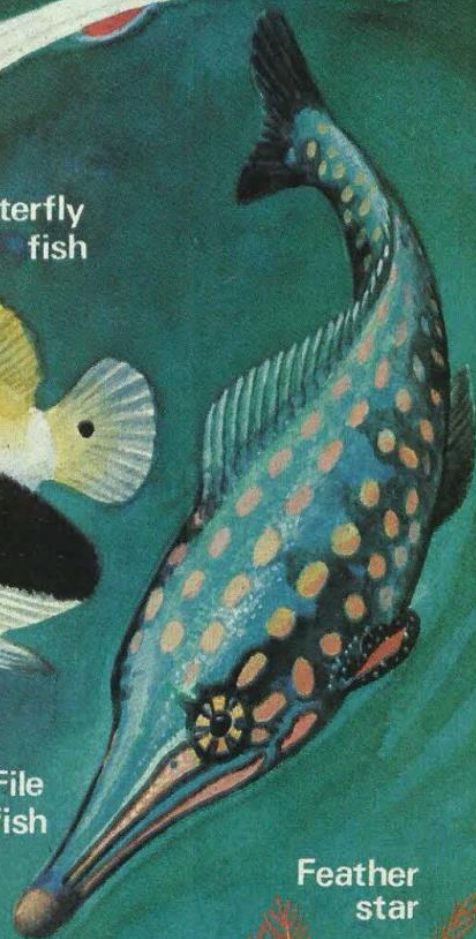
Vermilion
cod



Butterfly
fish



File
fish



Feather
star



Fan worm



Clown
fish

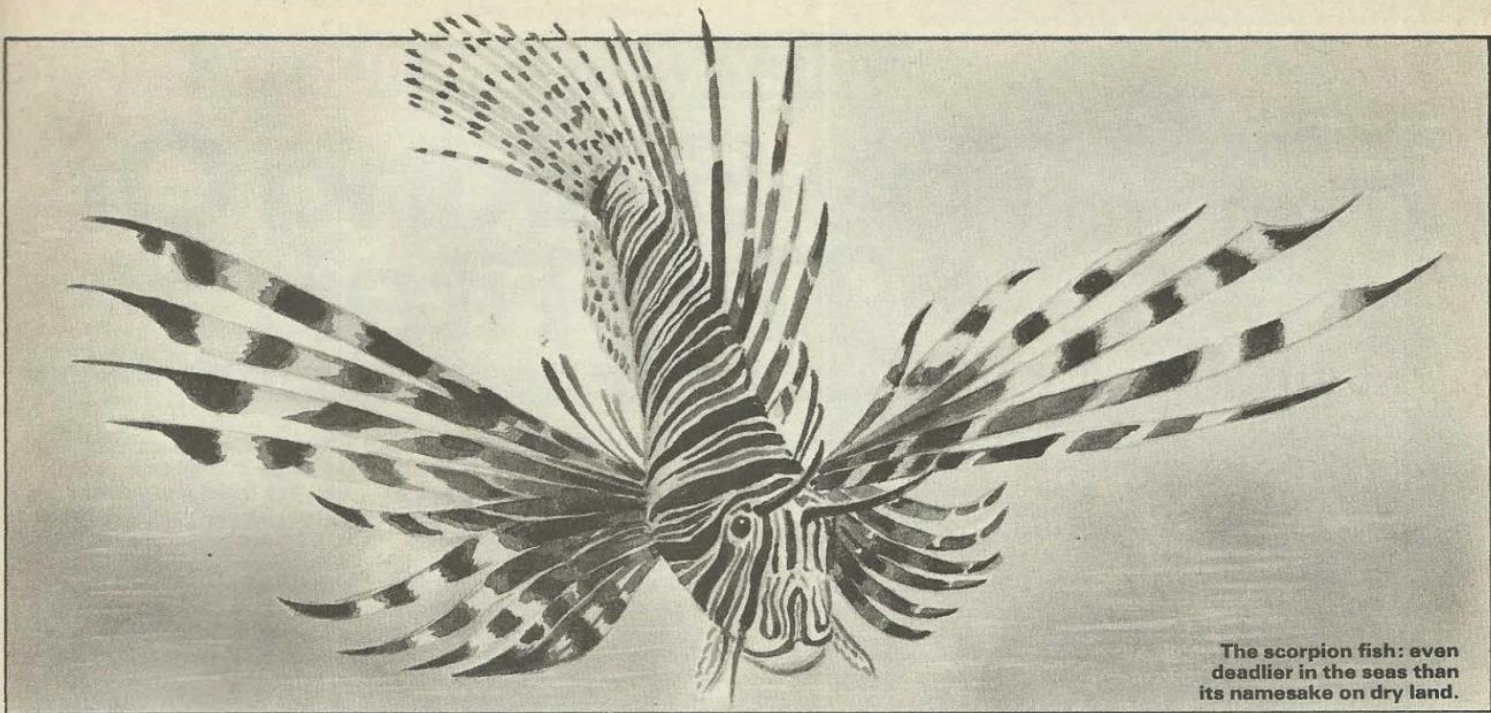


Anemones



Blue spotted
sting-ray





The scorpion fish: even deadlier in the seas than its namesake on dry land.

Illustrated by R.B. Davies

NATURE'S KINGDOM

Concluding our four-part series on the use animals make of colour in the fight for survival. This week — a look at life in and around the coral reefs . . .

Spot The Stripes!

ANYONE who has ever floated through the clear blue waters around a coral reef yearns to return again and again. The myriad of colours startle your eyes, while the shapes and movements draw your attention from one enchanting thing to the next. Around every coral-encrusted rock lies another more exhilarating surprise.

More than 100 million square kilometres of the sea bed are covered by coral reefs. These glorious barriers are the home of an extraordinary gathering of life. Fan corals of every description and colour gently sway in the sun-drenched currents, filaments of algae lead up to the surface and gracefully undulate down to the sand below.

Gaudy red columns compete for room with the white arms of the tree-shaped limestone formations, and the green organ-pipe coral; while at their base lie the solid round brain coral. But it is the many cracks and crevices of the reef which really hold its treasures.

These labyrinths provide a source of both food and protection for some of nature's most garish creatures. The most famous of these must be the angel fish, with its long flowing fins. This, and the brilliant butterfly fish, are among the brightest pair found along the reef. Both of these fish are armed with a deadly dorsal spine, which will pierce the roof of the mouth of any would-be predator.

The butterfly fish possesses a second secret weapon. As with many fishes in these waters, it carries the markings of one or more large black imitation eyes on its body and tail. The black stripe across its real eye seems to convince its enemies to attack the "fake" eye, thus giving the fish a better chance of survival, as its more precious head is rarely attacked first.

In complete contrast, the scorpion fish blends totally with its surroundings. As it skulks on the sea floor, waiting to pounce on any unsuspecting small fish, its mottled brown

colour and ragged leafy body make it nearly impossible to spot. It has the advantage of almost totally surprising its victim and, therefore, can usually inject its toxic venom successfully. As with most fish venoms, no known antidote exists for this poison.

The bright colours of most fish on a coral reef do not, on the whole, enable the fish to blend with their background, or warn predators that they may have a dangerous weapon. It would appear that, as in the case of the harlequin wrasse and the vermilion cod, the colour is more likely a warning that a territory is occupied, and therefore others must "keep out".

Charmed Life

Sometimes the colouration acts like that of a warship in battle dress. The outline of the fish is broken by the distinct patches of colour, which confuse the eye. The gaze is drawn to the markings and not to the whole shape of the fish.

A quite incredible fish with "dazzle" colouring is the relatively unfamiliar clown fish, whose colourful body is slashed by bold stripes. It is sometimes called the orange-anemone fish, because of its strange relationship with the large tropical sea anemones.

These invertebrates, which have every appearance of a plant rather than an animal, possess a fatal sting. Yet the clown fish can nestle deep in amongst the tentacles of an anemone and come out completely unscathed.

The clown fish adopts its own anemone, and defends its territory with some force. It takes its food into the heart of its host in order to eat unmolested. In doing so, scraps often fall to the sea anemone. There have been cases reported where an anemone has tried to snatch the prey from the clown fish, but has never been seen to be successful. One theory which explains the clown fish's charmed life is that it covers itself with a mucus which resembles that of the

anemone, this stops the anemone triggering its sting cells, and so the clown fish is safe.

The file fish is covered by spines as its form of protection. Its first dorsal fin is often a large single toothed spiny ray which can embed itself deep into an enemy. But more dangerous is its body which is covered in spines set so close together that its skin has the appearance of velvet.

Spines, venom, illusion, threatening colour — all these do serve to a certain extent as protection from predators for the massive numbers of creatures which inhabit the reefs. But the tropical reefs are a rich haven for all fish predators. One such is the barracuda which appears like a ghost from nowhere. It rapidly launches its attack on a victim, or more often a school of fish and gorges its way to satisfaction.

But what of the killer which stabs, possesses poisonous venom and is as deadly as a rattlesnake? The sting ray, which inhabits every corner of the tropical seas, is nearly as dangerous to man as it is to fish. It lies on the sea floor hidden under a thin covering of sand, waiting for any passing clam, crab, worm or sea snail. This it simply grabs and consumes.

But when suddenly surprised by a kick or tail lash, a whip of its tail sends the sting ray's victim reeling. The arrowlike tip and backward pointing teeth of the spine plunge deeply into skin and flesh with ease.

The barb cannot be removed without the venom seeping deeper into the wound and severe lacerations being caused. People who have survived sting ray attacks say the spine is driven right into the bone and causes the worst pain imaginable.

A coral reef is undoubtedly one of the greatest treasures of nature. The richness of colour and form is equally matched by the diversity of creatures. As with much in the world, however, extreme beauty hides extreme danger and savagery.

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Robbers Among The Rocks

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The perils of building the Afghan Railway—PAGE 30.



Flight Into The Future

The incredible success story of British Airways SEE PAGE 15.

INSIDE STORY



The incredible success story of British Airways began just 60 years ago when, from an airport just outside London, a tiny two-passenger aircraft took off and began a . . .

Flight Into The Future

POLITICIANS busily settling peace terms at the end of the First World War had a problem. They had vital work to perform in Britain, helping with the nation's recovery after four years of fighting. But they also needed to go to peace conference sessions in Paris.

To make frequent journeys by train and ship would have required a great deal of their valuable time. The newly-formed Royal Air Force came to their rescue. It formed a communications squadron in December, 1918, and set up an air ferry service between London and Paris, carrying members of the British Government to meetings in both capitals.

However, it was not until 25th August, 1919, that the world's first regular, international, scheduled, civil air service began. On that date, a de Havilland DH4A aircraft left Hounslow, London, at 9.10 a.m. and arrived at Le Bourget, Paris, 2½ hours later. It carried one passenger and a mixed load of cargo consisting of Devonshire cream, leather, newspapers and grouse. The flight was operated by Aircraft Transport and Travel Ltd.

The DH4A was a converted day bomber of the First World War. It was powered by one 350 hp Rolls-Royce Eagle engine, and carried a

maximum of two passengers and cruised at about 100 mph. Shortly afterwards, Handley Page Transport Ltd. started a London-Paris flight, but did not begin regular operations until later.

On that August day in 1919, a new story began — one that would lead directly from that single, lonely DH4A passenger to the more than 17 million passengers carried every year. And from the DH4A's speed of 100 mph to the 1,350 mph cruising speed of the supersonic Anglo-French Concorde.

The first airline services to the Continent were very regular and, as a result, Aircraft Transport and Travel Ltd. were awarded a mail contract by the Post Office. The first airmail letters left Hounslow for Paris on 10th November, 1919.

Much of the success of those early operations was due to the pilots, who regularly fought their way through in bad weather, assisted by only a very rudimentary ground organisation. One pilot once made 33 forced landings between London and Paris and took two days to complete his flight. To provide navigational assistance, the names of some railway stations were painted on the stations' roofs.

Unfortunately, the air service failed to make a profit, and it was

suspended in 1921. The services were restarted a month later with financial help from the Government. The airlines operating to the Continent received subsidies until the companies were merged to form Imperial Airways Ltd. in 1924. They flew to Paris, Brussels, Amsterdam, Rotterdam, Cologne, Zurich and the Channel Islands.

Aircraft which operated these services included, in addition to the DH4A mentioned earlier:

The Handley Page 0/400, a conversion of the 0/400 bomber, designed for use over Berlin. It

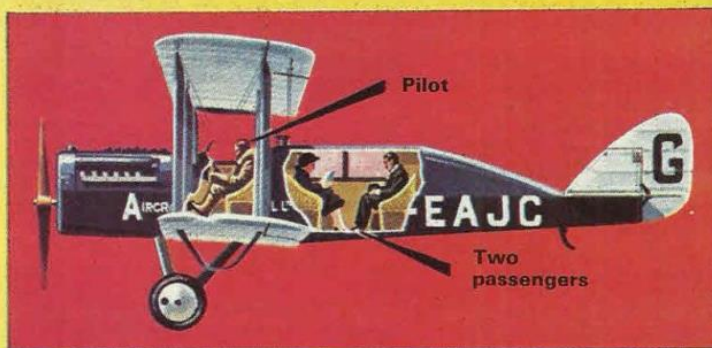
was equipped with the first Marconi air-to-ground R/T (radio telephone). Powered by two Rolls-Royce Eagle, Bristol Jupiter or Napier Lion engines, it carried up to 14 passengers.

DH34. Powered by a single Napier Lion 450 hp engine, it seated nine passengers in comfortable, wicker-cane chairs, and cruised at 105 mph.

Supermarine Sea Eagle. These carried six or seven passengers and flew to the Channel Islands.

Imperial Airways was formed

CONTINUED ON PAGE 18.



Top: Passengers in 1919 prepare for a flight to Paris in the open cockpits of an Aircroft (de Havilland) 9. Helmets, goggles, leather flying-suits and blankets kept passengers warm. **Above:** the Aircroft DH4A carried two passengers in an enclosed cabin. Both aircraft are in the colours of Aircraft Transport and Travel Ltd.

BRITISH AIRWAYS FLYING HIGH FOR 60 YEARS



Important landmarks in the history of British civil aviation are represented by the aircraft shown here.

1. 1919. **Aircro DH4A**. One engine. Range 375 miles. Passengers: 2. There were seven of them in the fleet.
2. 1922. **de Havilland 34**. One engine. Range 365 miles. Passengers: 9. Number in fleet: 7.
3. 1931. **Handley Page 42**. 4 engines. 38 passengers. 8 in the fleet. Famous for its safety, but not for its speed.
4. 1936. **Short S23 'C' class Empire flying boat**. 4 engines. 24 passengers. 31 in fleet. This plane carried air mail and passengers throughout the British Empire.
5. 1941. **Boeing 314A**. Four engines. 70 passengers (40 with sleeping accommodation). Range 3,685 miles. Number in fleet: 3. Shown in World War Two camouflage; the three aircraft were named Bristol, Bangor and Berwick. They flew Atlantic services throughout the war, and all

survived.
6. 1946. **Vickers Viking**. Two engines. 36 passengers. Range 1,875 miles. Developed from the Wellington bomber, designed by Sir Barnes Wallis, this was the first post-war, purpose-built airliner for BEA.
7. 1949. **Boeing 377 Stratocruiser**. Four engines. 81 passengers. Range: 4,000 miles. A great favourite with passengers because its "double bubble" or figure-of-eight fuselage carried a lounge and cocktail bar in its lower section.
8. 1953. **Vickers Viscount 700**. Four engines. 47 passengers. Range 1,600 miles. 26 in fleet. The aircraft illustrated, the prototype Viscount, made the first ever scheduled passenger flight by a turbine (jet) powered aircraft, from Northolt to Le Bourget on 29th July 1950. Its Rolls-Royce Dart engines

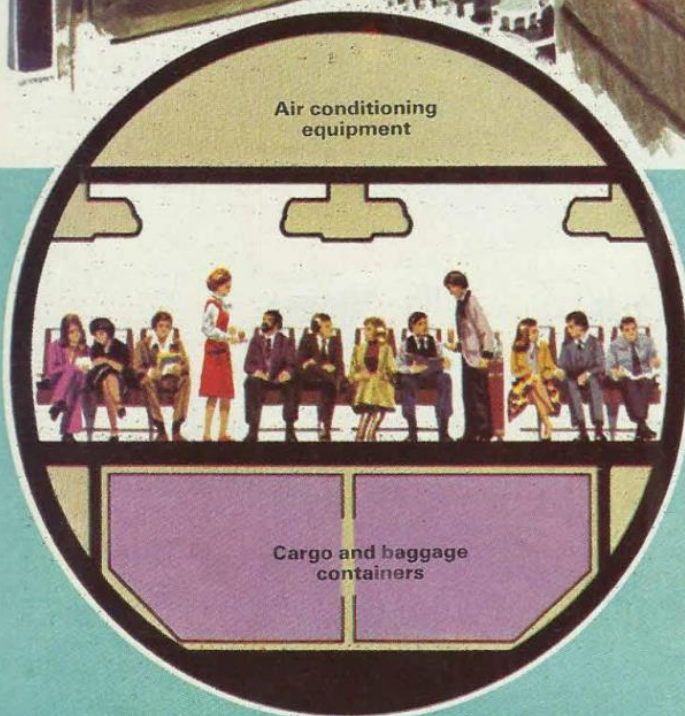
were turbo-props — jet engines driving propellers.
9. 1958. **de Havilland 106**. Comet 4. 4 engines. 81 passengers. Range 4,800 miles. 19 in fleet. The Comet 4s of BOAC and BEA (the one illustrated is Comet 4B) were the world's first jet airliner in service. Comet I.
10. 1960. **Boeing 707-420**. Four engines. 146 passengers. Range: 5,520 miles. 20 in fleet. This was the first of the big, four-jet airliners, which brought the jet age to the mass of air travellers.
11. 1964. **Hawker-Siddeley Trident 1**. Three engines. 99 passengers. Range 1,150 miles. For many years the mainstay of the BEA fleet, this plane has developed in size and power through several versions. Trident 2 is shown in our illustration.
12. 1964. **Sikorsky S-61N**

helicopter. Two engines. 26 passengers. Range: 420 miles. Number in fleet: 27. Used by British Airways to serve the North Sea oil industry, these helicopters fly to and from the rigs with men and equipment. British Airways operates a scheduled service to the Scilly Isles from Penzance in Cornwall.
13. 1970. **Boeing 747-136**. Four engines. 365 passengers. Range: 8,505 miles. Number in fleet: 18. This was the first of the now famous wide-body airliners, seating its passengers eight or ten abreast in its enormous cabin. A famous publicity point was that the length of the Wright brothers' first flight in 1903 was no greater than half the length of the 747's cabin.
14. 1975. **Lockheed TriStar** (L1011-1). Three engines. 320

passengers. Range: 2,677 miles. Number in fleet: 9. A shortened, long-range, version of this plane, the TriStar-500 is one of the newest additions to British Airways' fleet.
15. 1976. **BAC/Aerospatiale Concorde**. Four engines. 100 passengers. Range: 3,653 miles. Number in fleet: 6. Now well into its fifth year of passenger-carrying operations, this supersonic aircraft remains an outstanding technical achievement. Pilots and passengers love it.
16. **Hawker Siddeley HS 748**. Two engines. 48 passengers. Range: 1,300 miles. Number in fleet: 2. British Airways' use this tough, dependable aircraft mainly on internal Scottish services.



Air conditioning equipment



Cargo and baggage containers

The scale of modern air transport is best illustrated by the famous Boeing 747, aptly called the Jumbo Jet. Left: a typical cross-section of the cabin make a good comparison with the Airco 4A on the title page. The flight deck (above) houses (left to right): captain, first officer and flight engineer. For much of the flight they monitor the controls and instruments, while the aircraft flies and navigates itself, cruising at about 570 mph.

luxurious aircraft produced for the tropics.

Other planes used were the de Havilland DH91 *Albatross* (four engines, 22 passengers), and Short S23 *Empire* flying boat (four engines, 24 passengers).

The Short S26 class, *Golden Hind*, was the first of three S26 flying boats ordered by Imperial Airways. But before they were put into service, the war had started so, fitted with gun turrets, they served with the RAF on long-range reconnaissance duties.

Three companies operating internal services in the United Kingdom — Hillman Airways, Spartan Airlines and United Airways — were merged to become British Airways Ltd. in 1935. This company operated services from Southampton to the Isle of Wight, Heston, Blackpool, Isle of Man, and the Channel Islands, and routes to the Continent.

However, all airline operators were considerably criticised in Parliament and, in November, 1939, the British Overseas Airways Corporation was established. On 1st April, 1940, it officially took over the two airlines.

From then on the story is one of rapid progress. BOAC began, after a wartime interval, to rebuild and expand its world-wide network of long distance routes with a fleet composed mainly of converted military aircraft.

Passenger-carrying services were inaugurated between London

and New York in 1946, and BOAC improved the service as well as pioneering other routes.

Among the aircraft used on these were Boeing 377 *Stratocruisers*, the largest civil airliners in the world, Handley Page *Hermes 4* (the first British passenger plane with a pressurised cabin) and the *Comet*, with which BOAC began the world's first pure-jet scheduled passenger service. With the Boeing 707 and the BAC VC10 airliners, BOAC became a big jet operator, the equal of any of its rivals.

Meanwhile, its sister organisation British European Airways, was developing the European and domestic routes, using the Airspeed AS57 *Ambassador* on the London to Paris route. This was succeeded by the Vickers *Viscount*, powered by four Rolls-Royce Dart turbo-prop engines. Carrying 47 passengers it cruised at 316 mph.

Later versions were bought as they became available, and the use of this aircraft has continued into recent times.

BOAC and BEA were brought under one controlling authority, the British Airways Board, in 1971, and British Airways came into being three years later. Since that date, increasing progress has been made, notably with the introduction of the supersonic Concorde, the front-runner in transatlantic flight.

The British Airways fleet now stands at over 200 aircraft, including 30 helicopters.

on 31st March, 1924, and took over the fleets and services of the smaller companies. It inherited 1,760 miles of cross-Channel routes, and 18 aircraft.

Services to Europe were resumed, but the new company had the task of developing services to more distant places. In the years that followed, services were opened between Cairo and Basra in the Persian Gulf, and from London to India (1929), Singapore (1933), Australia (1935), and Cape Town (1932).

The vast stretch of the North Atlantic seemed an insurmountable barrier to the aircraft of the 'thirties. But on the night of 5th–6th July, 1937, an Imperial Airways *Empire* flying boat made history by flying non-stop from Ireland to Newfoundland. In 1939, Imperial Airways operated a series of eight regular transatlantic airmail services, though it was not until after the Second World War

that the first British commercial air transport service linked the United Kingdom with America.

The Imperial Airways' routes were flown by a number of different types of aircraft. Among them were the Armstrong Whitworth Argosy airliner (three engines, 20 passengers); the de Havilland DH66 *Hercules* used on overseas routes (three Bristol Jupiter engines, seven passengers); Short Calcutta flying boats (three Bristol Jupiter engines, 15 passengers); Handley Page 42E Hannibal Class and 42W Heracles class airliners (four engines, 18–24 passengers in two cabins, Hannibal; 38 passengers, Heracles).

The first monoplane ordered by Imperial Airways was the Armstrong Whitworth AW15 *Atalanta*. With four Armstrong Whitworth Serval engines, it carried nine passengers and cruised at 130 mph. It was described as the fastest and most

INSIDE STORY

The latest addition to British Airways helicopter fleet proves without doubt that . . .

The Helicopter Is Growing Up



Stripped of its seats, the Chinook becomes a heavyweight cargo lifter. It can carry 12,000 kg inside or up to 14,000 slung beneath it. Should it have to land upon the water (below), the helicopter should stay safely afloat in waves 10 metres high.

SINCE the 1930s, when a Focke-Wulf 61 and Igor Sikorsky's VS-300 rose into the air on the power of their rotating blades, helicopters have played an increasingly important part in the world of air transport.

The Boeing Vertol model 234 Chinook, which is going into service over the North Sea with British Airways

Helicopters next year, is a versatile craft that amply demonstrates how far helicopter development has come since those early experimental machines took to the skies.

The Chinook is capable of carrying 44 passengers at a speed of 130 knots on the journey from Aberdeen in the north of Scotland to the oil rigs in the Brent field in the

North Sea. Should there be any problems about landing upon a rig's helicopter pad at the Brent field, the helicopter will have enough fuel to enable it to divert for 112 nautical miles to another oilfield, or to remain in the air for 45 minutes while waiting to land.

The Chinook would refuel on the rig and return to Aberdeen. The commercial version will have a maximum range of nearly 550 nautical miles with 44 passengers, or nearly 670 nautical miles with 20 passengers.

In this form, the Chinook is classed as Model 234 Long Range. It can be quickly converted to a utility version, able to carry freight, or passengers and freight. For this operation, the whole cabin interior, bulkheads, floor, galley, toilet, ramp, baggage bins and some electronic equipment are stripped out.

Offshore operations occasionally require cargo to be transported, and the utility version can carry a total weight of 12,000 kilograms, or, with a load slung beneath it, the craft's total weight-carrying capacity can be increased to 14,000 kg.

British Airways Helicopters will get its first machine for crew training and validation by the licensing authorities in July, 1981. When four machines are delivered the service will be fully operational. These four craft will be used for checking

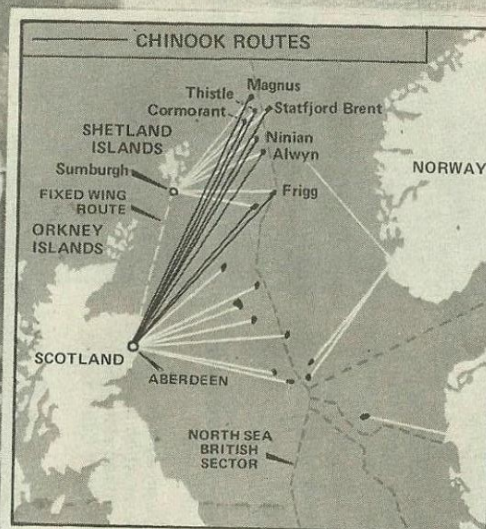
vibration, flight loads, acoustics, avionics, drive systems, night flying, flying qualities, failures, performance, take-off and landing, slung loads, high altitude flight and utility missions.

In all, the craft will undergo 260 hours of tests, and only after they have survived these most stringent trials will the craft enter service over the turbulent North Sea, carrying men and supplies to the oil rigs standing amid the heaving waves.

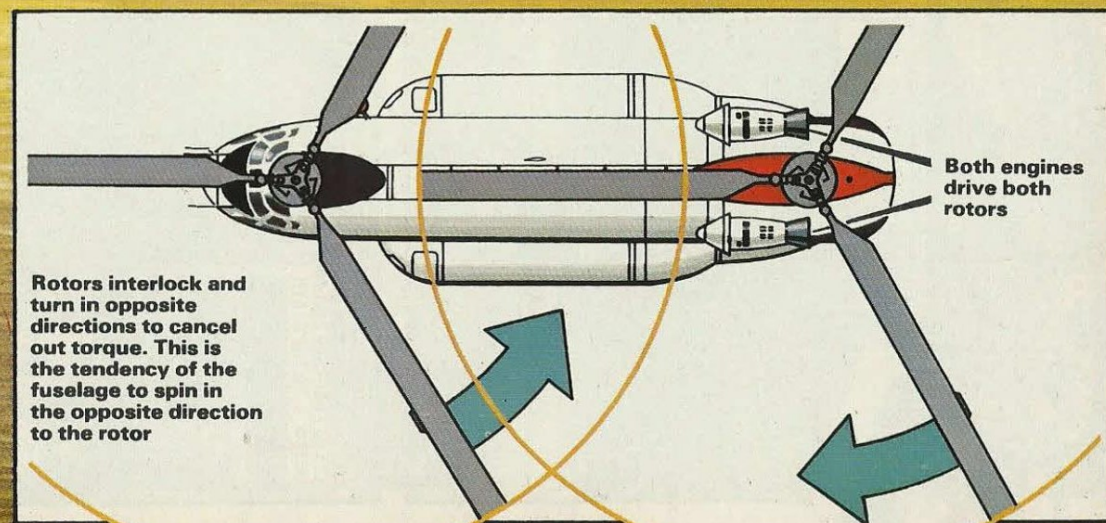
Should the Chinook be forced to descend, perhaps because of engine trouble, tests confirm that it is virtually certain to remain stable among waves that may tower as high as 10 metres.

For passengers, the noise while the helicopter is in flight could be well-nigh unbearable, were steps not taken to minimise this. The volume of noise has been drastically lessened by the use of plastic rotor blades, which reduce vibration. Several hundred kilograms of soundproofing material is laid round the cabin, and the cabin floor and the fuel tanks are isolated from the basic airframe by vibration dampers.

When it is in service, the new helicopter will be performing a vital job. It may greatly extend the distance offshore at which new rigs can be supplied. And it could even provide a service to several rigs on one trip, thus making a valuable contribution to a vital industry.



The map above shows some of the routes to the oilfields the Chinook will serve. Its long range will allow flights to the distant oilfields direct from Aberdeen. The white lines show the current, shorter range routes.



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LOOK AND LEARN

No. 976, 22nd NOVEMBER, 1980.

EVERY MONDAY, PRICE 35p.

MALTA—An Island Fortress

SEE PAGE 2

SUPERMAN OF THE SEABED

Read about an amazing underwater revolution — on page 6



INSIDE STORY

This modern diving suit, with its powered arms and claws, metal body and built-in air conditioning turns its occupant into a . . .

Superman Of The Seabed

FREEDOM of movement at tremendous pressures is the prime requirement of a deep-sea diver, and some of the men working beneath the North Sea on oil-rig maintenance have "suits"

which amply meet this need.

The equipment they are using is the One Man Atmospheric Submersible (OMAS) shown in our illustrations on these pages.

When a diver is wearing a suit

If an emergency makes a swift escape to the surface necessary, the diver can jettison many of his suit's accessories, such as the powered claws, communications cable and power pack. He is then able to rise because his suit has become sufficiently buoyant.

which does not resist the pressure of the water, his suit is inflated by air to overcome this, and he absorbs a great deal of nitrogen. If, in an emergency, he returns to the surface too quickly, the nitrogen forms bubbles in his blood, causing him great pain and possibly causing his death.

Normally, he would be put at once into a decompression chamber. A suit that counteracts the pressure of the water provides a better solution, if it enables the diver to breathe air at atmospheric pressure and to work at depth efficiently.

OMAS, made by Slingsby Engineering Ltd., is such a "suit". It consists of a lightweight, pressure hull with fully articulated arms that end in hydraulically-powered claws with which the operator can perform manipulative tasks.

Swift Escape

The diver in his OMAS is lowered by crane from his "mother" ship to the operating depth. The cable on which he is suspended also carries electrical power to the OMAS and provides circuits for a TV camera fixed above the helmet, and conveys data to the surface.

In normal circumstances, the diver would work at depth for eight hours. But should an emergency arise, he is able to survive for 72 hours inside the thermally insulated pressure hull.

The emergency systems include a facility for the operator to swim freely for 30 minutes, using emergency batteries after releasing the connecting cable.

He is able to communicate by sonar through the water to rescuers on the surface, and then to rise to the top after abandoning the hydraulic propulsion system, the hydraulic claws and an air buoyancy system, which are unnecessary when the neutrally buoyant vehicle is no longer operating at depth.

Divers using OMAS are able to inspect oil rigs and drilling platforms, to make tests and also to undertake light construction and salvage work.

They are strongly reliant upon the units on the surface. These consist of a control cabin and a jib crane aboard the "mother" ship. Housed in the cabin are the power distribution system, TV monitor and recorder, communications equipment and electrical protection circuits. The cabin is mounted

on a frame, to which the crane and hydraulic power pack are attached.

A total reach of five metres is possible with the crane fully extended. It can rotate through 360 degrees and is powered by a hydraulic motor.

When he is working far beneath the surface, the diver has a spotlight to shine upon his work, while his head is protected by a hemispherical acrylic dome, which gives him all-round vision.

The atmosphere inside the OMAS is kept pure by an electrically-powered "scrubber", which removes the carbon dioxide by recirculating the air through a chemical absorber. Oxygen is continually bled into the suit in order to maintain a normal-pressure air environment.

Devices such as this followed experiments in America with a pressure-resistant suit nicknamed "Jim". It was given the name of a diver, Jim Jarratt, who wore an early shell-suit to probe the wreck of the *Lusitania*, which was sunk during the First World War with the loss of 1,198 passengers.

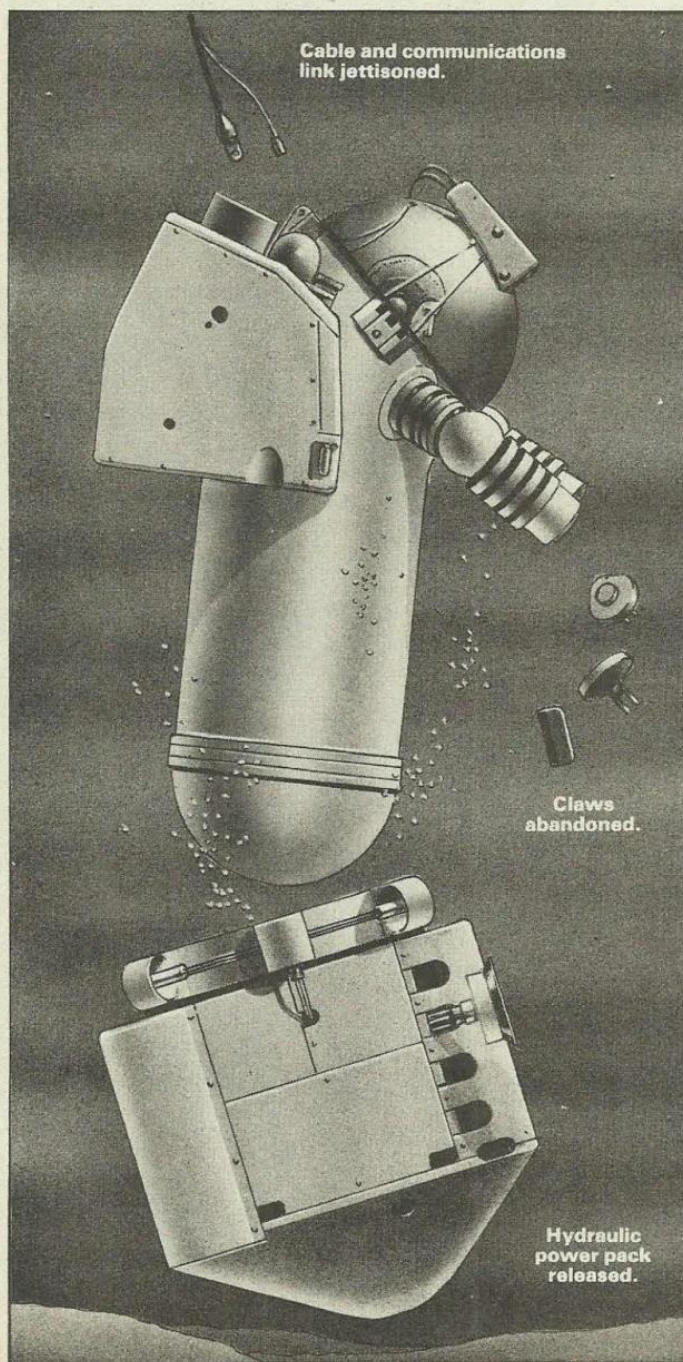
Breathing oxygen carried in a backpack, the diver using "Jim" could move freely with the help of flexible joints built into the suit's arms and legs. These joints were made of two rings of metal with a lining of oil to lubricate them.

At the end of each arm was a metal hand which was operated by the diver. This was very flexible, and with it the diver could pick up nuts and bolts and fix them in place. Another unit could be fitted to the arm to enable spanners and other tools to be used.

OMAS and "Jim" are two of the modern developments of a diving suit introduced in 1837 by Augustus Siebe. Made of rubber between two layers of fabric, it had watertight cuffs at the sleeves, heavily weighted boots and a copper helmet with two eye pieces.

Before this, the only equipment carried by divers was a stone, which helped them to sink. More useful for underwater work was a diving bell, consisting of a steel, open-bottomed chamber.

A diver used a wooden diving bell strengthened with iron for Ramsgate harbour works in 1784, and a cast iron one came into use 19 years later. Modern one-man submersibles, with their powered claws and great manoeuvrability, have given today's operators the ability to perform underwater work that their forerunners could never have envisaged.

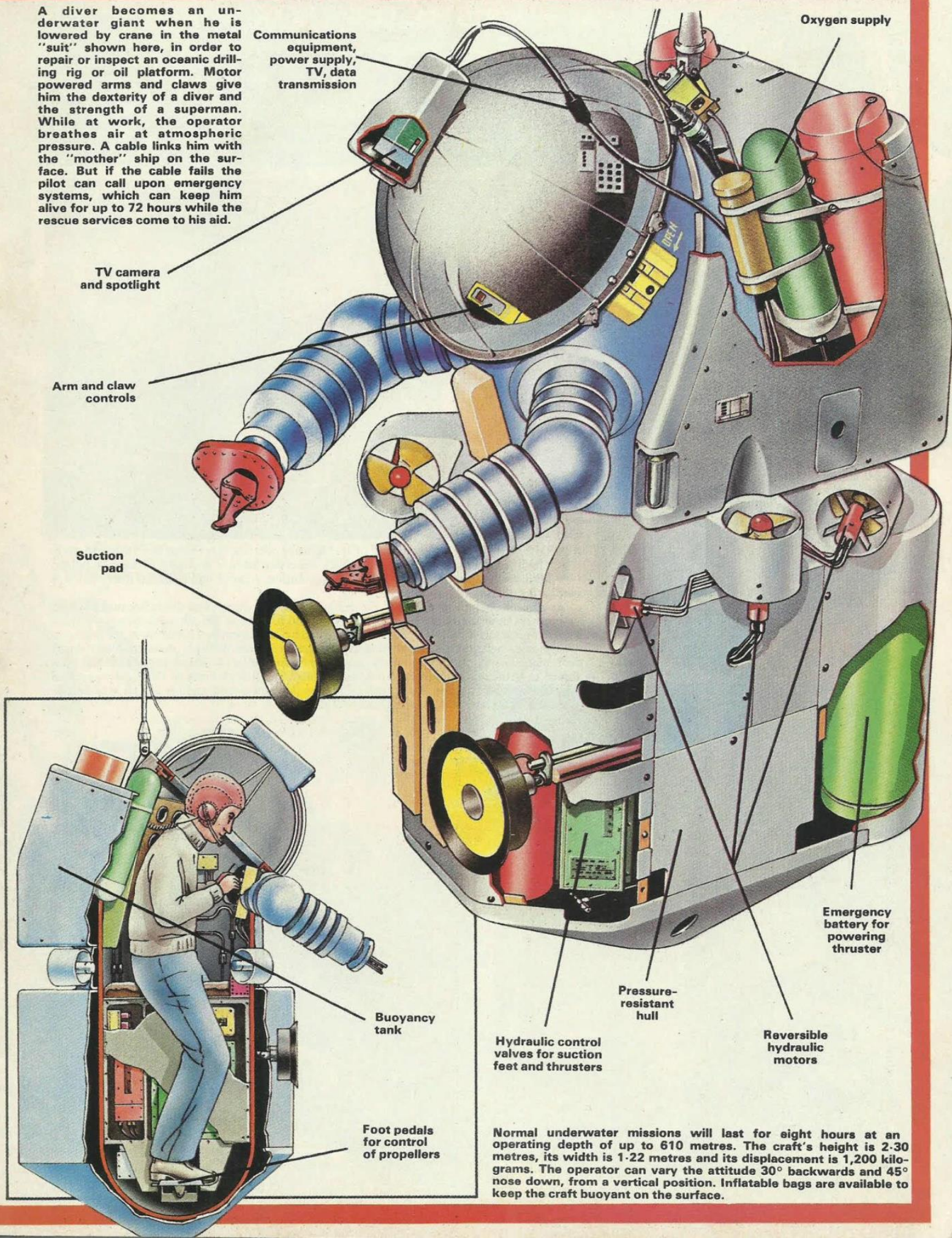


Cable and communications link jettisoned.

Claws abandoned.

Hydraulic power pack released.

A diver becomes an underwater giant when he is lowered by crane in the metal "suit" shown here, in order to repair or inspect an oceanic drilling rig or oil platform. Motor powered arms and claws give him the dexterity of a diver and the strength of a superman. While at work, the operator breathes air at atmospheric pressure. A cable links him with the "mother" ship on the surface. But if the cable fails the pilot can call upon emergency systems, which can keep him alive for up to 72 hours while the rescue services come to his aid.



Communications equipment, power supply, TV, data transmission

Oxygen supply

TV camera and spotlight

Arm and claw controls

Suction pad

Buoyancy tank

Foot pedals for control of propellers

Pressure-resistant hull

Hydraulic control valves for suction feet and thrusters

Reversible hydraulic motors

Emergency battery for powering thruster

Normal underwater missions will last for eight hours at an operating depth of up to 610 metres. The craft's height is 2.30 metres, its width is 1.22 metres and its displacement is 1,200 kilograms. The operator can vary the attitude 30° backwards and 45° nose down, from a vertical position. Inflatable bags are available to keep the craft buoyant on the surface.

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LOOK AND LEARN

No. 978, 6th DECEMBER, 1980.

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The Lion's Last Roar

THIS WEEK'S WARLORDS STORY—SEE PAGE 16

The Men Who Make Miracles

PART ONE OF A NEW SERIES—SEE PAGE 30



The Merchants Who Conquered A Continent

SEE THIS WEEK'S
FACT-FINDER

OF Britain's century and a half of railway history many relics remain, from the earliest days to more recent times. Enthusiasts are lucky to be able to see a collection of these preserved in magnificent order — at the National Railway Museum, York.

The museum constitutes part of the Science Museum, London, and was opened in 1975 by the Duke of Edinburgh. Many of the exhibits were formerly on show in the British Transport Museum at Clapham, in South London, or the railway museum which had existed in York since 1928.

The National Railway Museum is housed in what was once a steam locomotive depot, close to York station. This site was an inspired choice. Refurbished and extended, the buildings are eminently suitable for the purpose.

The Main Exhibition Hall, though light and airy, still has the unmistakable "feel" of the old loco shed from which it was adapted. The impression is enhanced by the two turntables which have been retained, and round which the larger exhibits are ranged.

Close Quarters

Locomotives and rolling stock can be viewed at close quarters from the floor of the hall, or as an imposing panorama from a wide balcony above. The exhibits vary from time to time, as some are taken out for maintenance or for loaning out, and new exhibits arrive.

In the case of engines or rolling stock that are in running order, they may be sent out on exhibition runs. Bringing them in or out is facilitated by a track link with British Rail.

It is probably the steam locomotives which first catch the attention — from the 1829 Agnoria colliery locomotive to the streamlined Mallard, which in 1938 set a world speed record for steam of 126 mph.

One of the locomotives on view, a Southern Railway Merchant Navy class Pacific, is shown with much of one side cut away, to reveal the interior of the cylinders and construction of the boiler and other parts.

Steam does not monopolise the floor. Other forms of traction are represented, from horse-drawn rail vehicles to electric and diesel locomotives. There are also many interesting examples of passenger rolling stock, showing how travelling comfort progressed over the years. For elaborate elegance it would be hard to beat Queen Victoria's saloon, originally built in 1869.

The display of full-scale exhibits is supplemented by an abundance of models of locomotives and rolling stock of various periods. Also

Concluding our series on . . .

Britain's Railway Wonders

From the days of Stephenson to the present day, the story of the railways comes vividly to life at York's unique museum.

to be seen in the wall-cases are working models of valve-gear systems and other locomotive technical details.

There is more to a railway than engines and rolling stock. Such important subjects as signalling, track construction and bridging are not neglected, nor are such interesting "railwayana" as staff uniforms, station notices, posters and even tickets.

Show-cases in the balcony contain exhibits illustrating the history of the railways. Other interesting items, including some fine railway paintings, are to be seen in the Front Gallery, just off the entrance hall.

One essential part of the buildings is not open to the public. This contains the workshops, where restoration and maintenance of exhibits is carried out.

There is a well-equipped lecture and film theatre, and the museum offers special facilities for school parties. Admission to the National Railway Museum is free, and normal opening hours are from 10 a.m. to 6 p.m. (Sundays 2.30 to 6), but the museum is closed on certain public holidays.

Locomotives and rolling stock in working order, like this former Southern Railway Schools Class locomotive, sometimes leave the museum on exhibition runs.



The Main Exhibition Hall at the museum covers an area of over two acres with the larger exhibits grouped around two original turntables.



hibits grouped around two original turntables. Photographs by Gary Merrin



Outstanding among the locomotives on display is the Mallard (right), the record-breaking steam engine.

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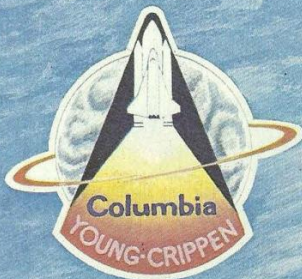
LOOK AND LEARN

THE MAKE-OR-BREAK SPACE MISSION

SEE PAGE 16.

No. 979, 13th DECEMBER, 1980.
EVERY MONDAY, PRICE 35p.





INSIDE STORY

The whole of America's space programme depends on the maiden flight of the space shuttle which sets out next year on a . . .

Make~Or~Break Space Mission

THE first flight of the American space shuttle in 1981 will be the most critical event in space history. Not only will the future of the utilisation of space depend on the success of this first test flight of the reusable and versatile spaceplane, but also, for the first time, man will be flying on the maiden flight of a spacecraft.

Apollo, Soyuz, Mercury and Vostok; all these were sent into space on unmanned test flights before being entrusted with a crew. The Saturn 5 monster rocket, that launched men to the Moon, flew on two test missions before carrying astronauts. The space shuttle, on the other hand, comprising an orbiter, external fuel tank, solid rocket boosters and a main engine system, the most complicated and technologically-advanced vehicle ever built, will be fired into space with a crew on the first mission.

The space shuttle project was initiated in 1972, the most ambitious and advanced space project yet. The money allocated for its development has been unrealistically low. As a result, corners have been cut, which have meant that the craft has been built with fewer of the back-up systems that helped to make Project Apollo so successful.

All this makes the job of the space shuttle astronauts, John W. Young and Bob Crippen, an unenviable one. Indeed, Young has said that the first flight has only a 50 per cent chance of

success, such as the numerous technical hurdles that need to be overcome, step-by-step, on the complicated three-day test flight.

Young is a veteran astronaut, chosen by NASA nearly 20 years ago. He flew pioneering flights in Earth orbit aboard Gemini 3 and Gemini 10 in 1965 and 1966 on moonflight rehearsals and, three years later, flew around the Moon in Apollo 10 on the final moon-landing test mission. In 1972, he became the ninth man on the moon. Young's co-pilot on the shuttle is Bob Crippen. Crippen was originally an astronaut of the US Air Force's Manned Orbital Laboratory, a project cancelled in 1969. Crippen was transferred to the NASA space corps.

Young and Crippen have been training for the STS1 mission, as it is called, since March 1978. This is the longest specific flight training any astronauts have undergone, partly because of the delays.

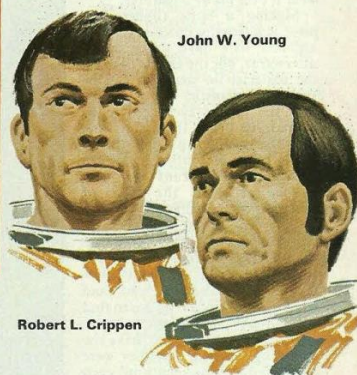
The first goal of the STS1 mission will be a successful countdown and launch. This may sound obvious, but just to achieve this will be somewhat of a triumph. Apollo was considered a complicated space vehicle, but the space shuttle is much more so.

The shuttle orbiter in which the crew fly fires on three main engines, which are fed with liquid oxygen and liquid hydrogen propellants from a large storage tank, called the external tank, on which the orbiter rides piggy-back

style. To each side of this tank are attached the solid rocket boosters, called solid because the fuel they use is a solid propellant.

When it leaves the launch pad, the strange-looking shuttle combination will be firing on five engines. This thrust is second in power only to that of the Saturn 5 rocket. The main engines will burn for 520 seconds, long after the solid rocket boosters have been ejected 124 seconds after launch. It is during this period that the mission may have to abort.

If this is the case the orbiter will separate from the external tank, turn and fly back to the launch site at Cape Canaveral. That may



John W. Young

Robert L. Crippen

The commander and pilot (above) for the first shuttle-flight into orbit, and the back-up crew, have spent hundreds of hours in the simulator, "flying" the mission with the controlling technicians feeding in problems and equipment failures for them to deal with. Young is pictured on the left carrying out a simulated landing.

sound easy but it would be the most difficult manoeuvre ever performed by a spacecraft.

Assuming everything works normally, the main engine system will shut down and the external tank will be ejected at 10 minutes 43 seconds into the mission, called T + 10:43. The orbital manoeuvring system, called OMS, which are smaller rockets, will nudge the spacecraft into its initial orbit with a two-minute firing.

The orbit will have a high point, called the apogee, of 250 kilometres and a low point, or perigee, of just 90 kilometres. The shuttle will be travelling at about 25,000 kilometres an hour. An important safety measure will then have to be taken, the venting of any residual, or left-over, fuel in the main engine system.

First the liquid oxygen will be vented and then the system purged with inert, or non-combustible, helium gas. Secondly, the operation will be repeated with the hydrogen lines in the main engine.

The fuel-dumping complete, the orbiter will be ready for its second OMS burn, at T + 45:50. This will raise the orbital height and place the orbiter in a perfectly circular path around the Earth 250 kilometres up.

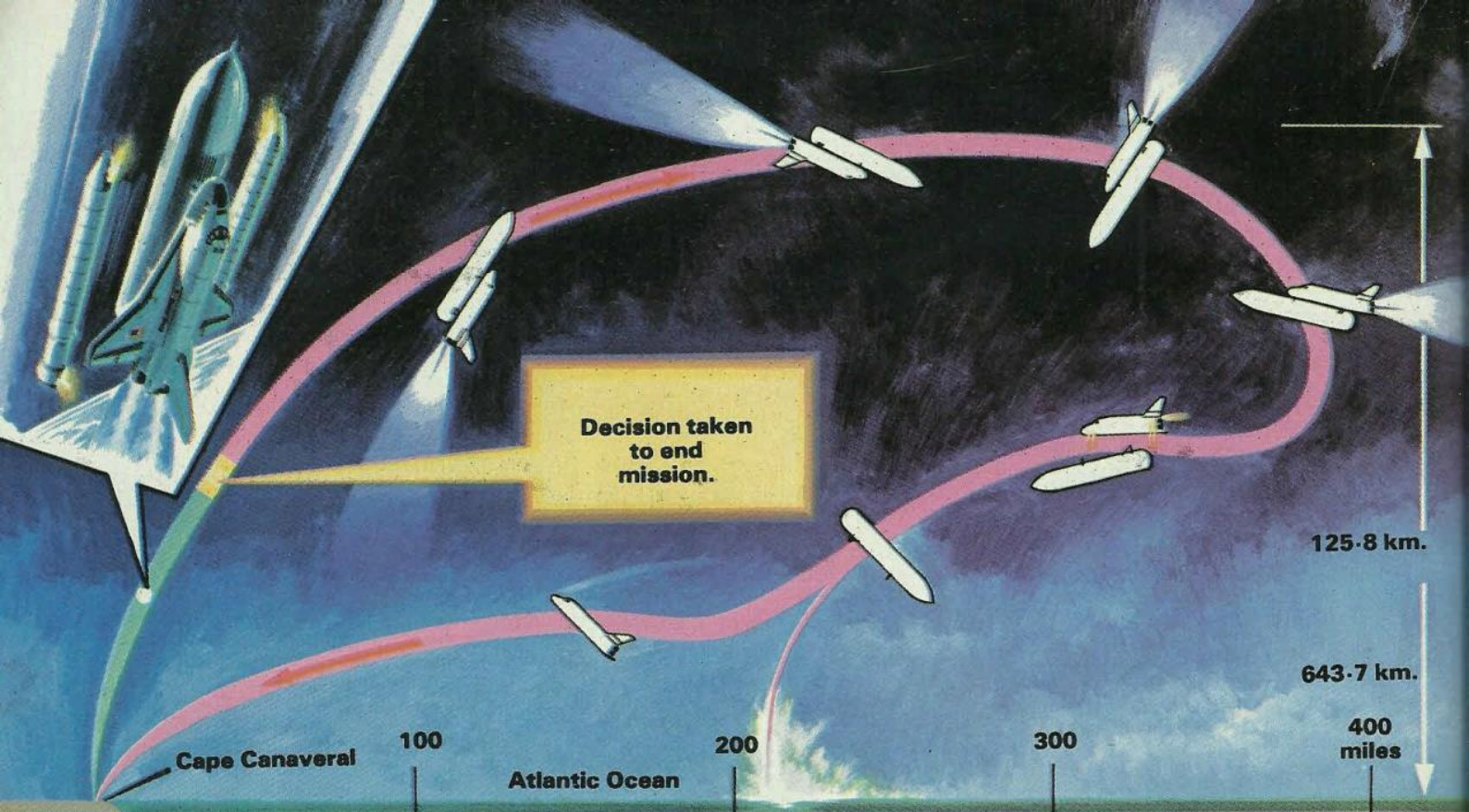
After detailed computer programming checks for the orbital phase of the mission, the crew will perform the first operational task — opening the payload bay doors. The payload bay of the space shuttle is an enormous equipment area in the mid-fuselage of the orbiter, which measures 4½ metres wide by 18 metres long. In this, the orbiter will on later flights be able to carry small space stations, satellites,

CONTINUED ON NEXT PAGE

Two separate "burns", or firings, of the pair of small orbital manoeuvring rocket engines place the shuttle in its final orbit.



HARDY



The very difficult abort manoeuvre must be flown to bring the shuttle back to a safe landing at base in the event of trouble during the ascent. The diagram above shows how the pilots must somersault the craft and its fuel tank to turn it for home. Flying this path and successfully dropping the tank demand great skill under pressure. Young and Crippen are hoping that they will not have to "abort" on the first mission.

manoeuvres of attitude, the positioning of the orbiter in space, using reaction control system thrusters, operated by a flight control system controlled by computer programmes.

The crew will spend a lot of time practising the complicated re-entry manoeuvres. The astronauts have summed up this phase of the flight as typical flight-testing of a new aircraft. It is very basic and will probably not capture the attention of the public.

What will capture the public's attention, though, will be the first test of the thermal tiles, the components that will, it is hoped, make the space shuttle the first re-usable spacecraft.

The re-entry sequence will begin on the third day in orbit, as the spacecraft is turned upside down, with its retro-rockets in the tail facing the path of travel. The retro-rockets, the OMS system, will fire and slow the craft down, so that the pull of the Earth's gravity will cause it to "fall" out of its orbit.

Still at high speed, and with its nose pointing forward and the right way up again, the orbiter will start to skim into the upper layers of the atmosphere. Gradually, the outer skin of the craft, particularly its belly and the leading edges of its wings, will heat up and glow red.

An unprotected spacecraft would be now a flaming meteorite. Earlier manned craft had heatshields which burned away during re-entry, absorbing the heat. With a burned-off heatshield, the craft could not be used again. But the shuttle's thermal tiles will heat up and absorb the heat in much the same way as the grilles of a gas fire.

They will glow red, then cool down as the craft reduces speed in the lower layers of the atmosphere. If one of the tiles were to come loose during re-entry, it could be catastrophic.

Approaching Edwards Air Force Base in California, Young and Crippen will glide the orbiter down for a runway landing.

rocket stages, experiment packages and other equipment, weighing up to 30,000 kilograms.

So the successful operation of the payload bay doors is critical to later missions, but it is equally so also to the first mission, for two reasons. They need to open to expose the orbiter's radiators to space. If they cannot operate, the spacecraft will have only enough water for seven orbits. It is important, too, for the doors to close. If they do not, this could cause dreadful problems during the high temperature, high speed re-entry into the Earth's atmosphere at the end of the mission. If they do not close completely, Bob Crippen will be detailed to close them manually during a spacewalk.

Crippen will also be making an inspection of the outside of the orbiter to ensure that all the thermal tiles are intact. If some of them are not, then during the re-entry, the high temperature and aerodynamic drag on the orbiter's surface could cause an enormous, and potentially lethal, hole to be burned away on the spacecraft. Crippen will be able to make minor repairs to the tiles.

Before the orbiter can be declared fit for its three-day flight, two more "housekeeping" jobs need to be performed. The orbiter will be aligned, or positioned in orbit, using a star tracker called IMU, and also the spacecraft's fuel cell system will be purged to ensure that electrical power is being generated.

This done, the astronauts will take off their spacesuits and sit back and relax for a while, taking a meal. On the fifth orbit, they will begin the operational phase of flight-testing in orbit. Basically, these flight tests involve

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THE SPANISH CONQUISTADORS WHO WENT IN SEARCH OF THE

SEVEN CITIES OF GOLD

SEE PAGE 22.

THE WARLORDS

The General Who Never Lost A Battle

In the night of 21st/22nd June, 1941, Adolf Hitler launched the most powerful force the world had ever seen against Stalin's Russia. It would be all over by the end of the year, he thought . . .

Georgi Zhukov

ALMOST without a halt, the victorious German armies raced hundreds of kilometres from the border until at the beginning of December their advance units were within sight of the spires of the Kremlin. And there the attack halted. The Russian winter had descended with all its fury, and the Nazi armies, devoid of winter equipment, froze into immobility; it was so cold that the tank engines had to be kept running all night to stop the engines freezing solid. Then, their supply lines over-extended, they ran out of fuel. This was not all. At Moscow the Nazi generals, conquerors of Poland and France, came up

against their better: General Georgi Zhukov. Conscripted into the Tsarist army in 1915, Zhukov had served as a brave NCO — twice winning the Order of St. George, the highest Russian award for bravery — before transferring his allegiance to the Bolshevik Red Army in 1918. After defeating the Japanese in Mongolia in 1939, and saving the Soviet Army from catastrophe in the war against Finland in 1940, Zhukov had an unrivalled reputation. Stalin gave him command of six armies to defend the capital. His iron will and brutal

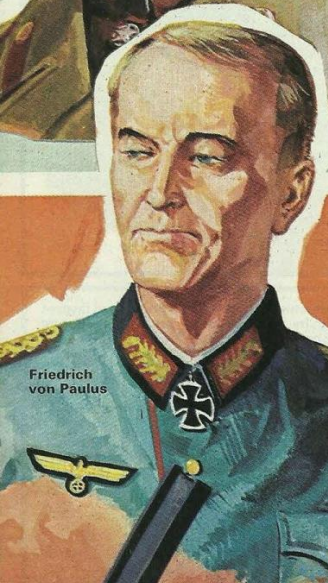
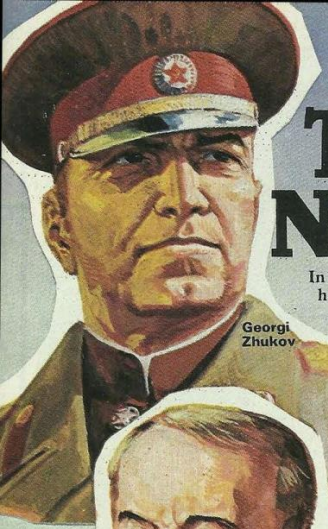
determination stood him in good stead as he marshalled the defence, and then delivered a massive counter-attack that set the Germans reeling. Only a stream of orders, and dire threats, from Hitler, saved the Germans from the fate which had overtaken Napoleon in 1812. Yet it was a stunning defeat for Hitler — his first — and the Germans would learn to fear the name of Zhukov.

WHILE Zhukov had been forging his reputation in the heat of battle, General Friedrich von Paulus had made a name for himself as a planning officer on the German General Staff. Ambitious and desperately eager for a field command, he finally got his chance when Hitler decided in 1942 to strike for Stalingrad on the Volga river. At first victory seemed assured, but in the very streets of the battered city the Russians, their backs to the river, stood firm. As the bitter hand-to-hand fighting progressed, Zhukov prepared his counter-stroke. When he moved against Paulus in January, 1943, the results were devastating. The German general found himself encircled and, finally, abandoned. When he surrendered, only 90,000 of a force of well over 300,000 were alive to march into captivity. The myth of German invincibility had been shattered.

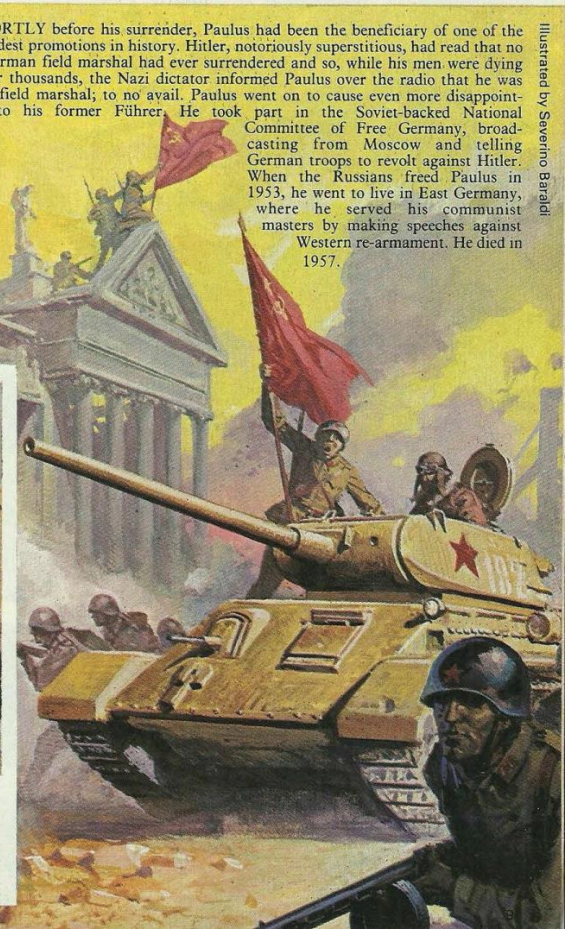
HITLER had always believed that Russian resistance would collapse "like a house of cards", and he could not understand why peasants living in a Communist régime fought for their country. And fight they did. Organised into tough partisan units they joined with hand-picked soldiers and ceaselessly harassed the stretched German lines of supply. Bringing men and ammunition to the front became a nightmare.

SHORTLY before his surrender, Paulus had been the beneficiary of one of the oddest promotions in history. Hitler, notoriously superstitious, had read that no German field marshal had ever surrendered and so, while his men were dying in their thousands, the Nazi dictator informed Paulus over the radio that he was now a field marshal; to no avail. Paulus went on to cause even more disappointment to his former Führer. He took part in the Soviet-backed National Committee of Free Germany, broadcasting from Moscow and telling German troops to revolt against Hitler. When the Russians freed Paulus in 1953, he went to live in East Germany, where he served his communist masters by making speeches against Western re-armament. He died in 1957.

Illustrated by Severino Brandi



AFTER the victory at Stalingrad, Zhukov was Russia's undisputed military genius. They called him "the general who never lost a battle", and he would be called in whenever the situation was desperate. Although he argued with Stalin over tactics, he kept a good relationship with him right up to the end of the war. And when the time came for the final assault on Berlin, Hitler's capital, it was to Zhukov that the honour of leading the attack was given.



INSIDE STORY

THE MAKE-OR-BREAK SPACE MISSION — Part Two.

Once they have put themselves in orbit around the Earth, the crew of the shuttle begin . . .

Getting To Work In Space

Small canisters called "get-away specials" will fill up every available nook and cranny on each flight. Here, New Jersey High School science students use a plywood mock-up to ensure that their experiment (the effect of weightlessness on an ant colony) will eventually fit into one of the canisters.

The international space shuttle in action, with the crew working and living in pressurised comfort. Above is the Spacelab, and behind it in the cargo bay are experiment-carrying pallets. These can be changed for each mission. Like the flight crew, scientists and engineers have conducted week-long "flights" in simulators. Floating through the airlock tunnel, the crew come to the living and sleeping area. Gliding up the ladder, they arrive at the flight deck. Behind the seats are the panels of controls for operating the equipment. These include the hand controllers for operating the Remote Manipulator.

within the orbiter cockpit. Windows at the rear of the cockpit allow him a full view of the payload bay. The "shoulder joint" of the arm will be just two metres away. He also has other visual references through TV monitors, which carry pictures from a TV camera in the "hand" section of the arm, and cameras in the payload bay. With the aid of two hand controls, he can manipulate the arm to perform all sorts of tasks.

Objects such as satellites that need to be deployed by the RMS are fitted with a compatible adaptor, which easily fits the "hand" of the RMS with a tight grip. The RMS "hand" and adaptor system is quite ingenious. The adaptor is essentially a spike and the "hand" consists of two rings connected by wires to form a cylindrical outline, rather like a double lasso. The cylinder is moved over the spike and the rings are rotated in opposite directions, thus causing the wires to tightly snag the spike adaptor.

The RMS can be moved at a maximum speed of 600 mm a second and can handle payloads as heavy as 29,500 kilograms, and 4.6 metres in diameter by 18.3 metres long. A payload retrieval would take about 45 minutes and the deployment of a satellite could be conducted in just nine minutes.

The RMS will be fully tested during the second, third and fourth test flights of the shuttle and will be called upon to deploy a satellite called the Long Duration Exposure Facility on mission 12.

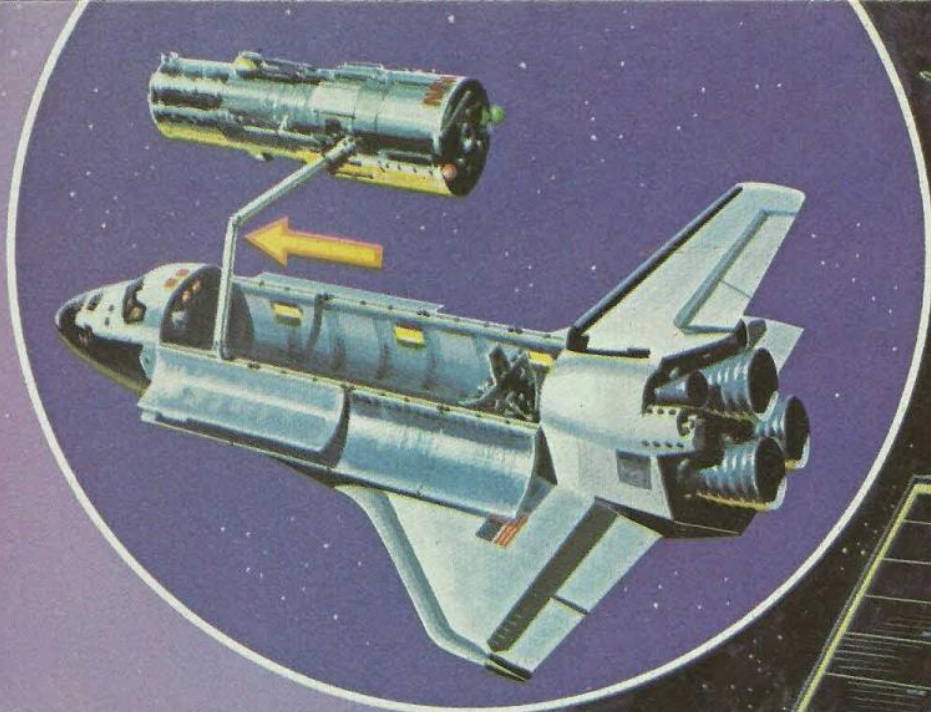
Another method of deploying satellites from the payload bay will be launching them on rocket stages. The standard orbit of the shuttle will be a low one, but the majority of satellites deployed by it, such as communications satellites, will need to be sent into higher, deeper orbits and, in the case of planetary probes, out of Earth orbit completely. These craft will be equipped with special rocket stages powered by solid fuel. One is called the Interim Upper Stage (IUS), which is designed to send up heavy satellites. It could send a space probe towards the planet Jupiter. The IUS will be placed in its launching position outside the payload bay by the RMS.

The second type of rocket stage is called the SSUS or Solid Spinning Upper Stage, and in fact two versions have been built, to handle smaller payloads.

The launch sequence of these SSUS rockets and their satellites will depend on the successful operation of a "spin table" technique. Once the shuttle orbiter is in orbit, its payload bay doors will open and the SSUS rocket with the satellite on top of it will be automatically positioned upright on a spin table in the payload bay. The stage will then be spun at between 65 and 100 revolutions a minute and released. The spin-stabilised rocket will move a safe distance from the shuttle before firing its engine and heading for an operational orbit. Up to four SSUS stages and their payloads can be carried at one time in the shuttle.

The teleoperator is another piece of shuttle equipment. It will serve both as re-booster of old satellites into higher orbits and a satellite inspector and "kidnapper", that could return a satellite to the shuttle payload bay for repair and relaunch or take it back to Earth for repair and inspection. The military implications of this capability are clear. The teleoperator could

CONTINUED ON NEXT PAGE



The Remote Manipulator System (arrowed above) is shown here being used to put into orbit the large space telescope, which will give astronomers a view of the universe with vastly greater clarity than is possible from Earth observatories. The advantages of this type of launch (as opposed to rocket boosters) are obvious. There are humans on hand to ensure that the telescope is fully operational from the start. Right: after about five years, the spacemen will come back to check and service the telescope. If necessary, it can be taken back to Earth in the same way in which it was transported into space.

also be used as a kind of expensive space garbage disposal unit, firing old and useless satellites into the atmosphere for safe destruction.

Other additions to the shuttle are planned later. These include a larger solar wing which can be deployed from the payload bay to provide additional electrical power for experiments in orbit. The solar panel would contain small solar cells of the kind which today are powering many satellites by converting the sun's energy into usable electrical power.

Other plans include the addition to the shuttle's solid rocket boosters of strap-on power modules to increase the thrust, to allow the shuttle to get into a higher orbit to carry a heavier payload. A new liquid-fuelled rocket stage may be added to the external tank as well.

Before these pieces of space equipment can be used, however, the shuttle has to be declared operational. It is hoped that after what proves to be a successful maiden flight by astronauts Young and Crippen, only three more test flights will be required.

By Flight 5 in the late summer of 1982 the shuttle should be operational. This flight will see the launching from the payload bay of a TDRS satellite. This is an important communications satellite which will provide instant communication between the shuttle control centre and the shuttle orbiter, wherever it is in orbit, as well as providing additional communications satellite capability to the rest of the world.

The TDRS will be launched from the shuttle on a SSUS rocket stage. Further satellites will be deployed on the later shuttle flights which will also carry what are called "Getaway Specials" — or packages of experiments placed in the payload bay for the duration of the mission, at a very small cost.

These "Getaway Specials" will enable universities and other research establishments to carry out important experiments cheaply, and

at the same time enable NASA, the United States space agency, to fill every nook and cranny of the shuttle with experiments and payloads. NASA want as much business as they can get to help with their great costs.

On the ninth shuttle flight, the first Spacelab space station will be carried in the payload bay. Spacelab has been built by the European Space Agency, called ESA. During the week-long mission, scientists will carry out a variety of experiments from the Spacelab before returning to Earth, without actually leaving the shuttle.

Six-man Crew

The subjects of experiments to be conducted include: atmospheric physics and Earth observation, space plasma physics, material sciences and technology, astronomy and solar physics, and life sciences. The first Spacelab will be crewed by six astronauts. These will include two pilot-astronauts, the commander and the pilot, and four scientists.

Two of these will be scientist-astronauts in the NASA corps of spacemen, and they will be called mission specialists. They are Owen Garriott, who flew on board the Skylab space station, and Dr Robert Parker. The other two crew will be payload scientists, flown to operate specific experiments.

The shuttle missions will become quite routine by this time and some will be busier than others. For example, on Flight 17 four satellites will be carried and deployed in orbit. They will all be communications satellites, two

belonging to other countries and two being US commercial satellites.

All the shuttles will be flown from the Kennedy Space Centre at Cape Canaveral until number 30, which will be launched from the Western Test Range in California. The WTR, as it is called, is a military base. Most launches from there will carry secret payloads such as spy satellites, missile launch detection satellites, and other monitoring equipment.

The plan is for five shuttle orbiters eventually to be built. The *Enterprise* was the first. This was used for test flights in the atmosphere, called the approach and landing tests, in 1977. These involved the dropping of the orbiter from the fuselage of a Jumbo jet for glide tests with a crew of two. The second shuttle, *Columbia*, is to be used for the test and initial operational flights. The third orbiter, called *Atlantis*, will be flown first on the Spacelab 1 mission, on Flight 9, while the fourth, *Discovery*, will fly first on Mission 25, which will be deploying the space telescope into orbit. A fifth orbiter called *Challenger* has yet to be built.

By the time 40 operational missions have been completed at the end of 1984, over 50 satellites and space probes will have been launched by the shuttle, hundreds of "Getaway Specials" will have been carried and eight Spacelab missions flown. In the future, the shuttle will be used to build space stations piece-by-piece, later ferrying crews backwards and forwards. Other schemes see it helping to construct solar power stations which can beam electricity down to Earth.

NEXT WEEK: The Women Who Will Conquer Space

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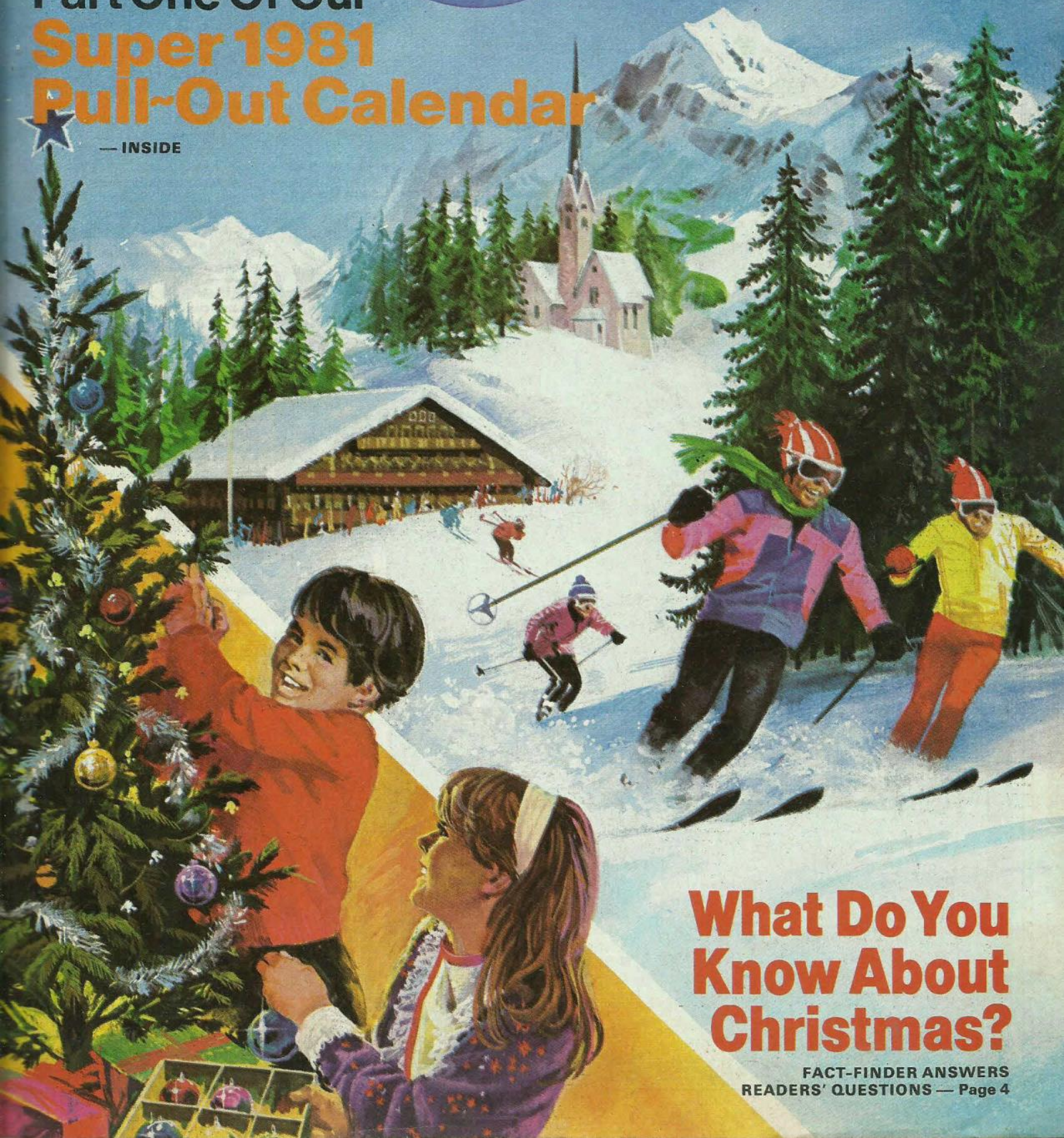
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FACT-FINDER ANSWERS
READERS' QUESTIONS — Page 4

INSIDE STORY

Part 3 of our series about the make-or-break American space mission

The Women Who Will Conquer Space

For years the question was "Who will be the first man on the Moon?" Now, at last, women are making their own valuable contribution to space exploration

AMERICA'S first women astronauts — and a husband and wife team of doctors — are destined to fly off into space when the United States begins trial flights with its space shuttle during the first half of the 1980s. They will be included in the crews of these space vehicles, for which four types of astronauts are being trained.

There will be a commander and a pilot, both qualified pilot-astronauts. In charge of the experiments and the general mission will be "mission specialists" who are qualified astro-scientists. The fourth category will consist of scientists brought in to operate experiments with which they have been previously involved.

At NASA's Manned Spacecraft Centre in

Houston, Texas, there are 81 astronauts in training. Of that number, a group of 35 and another of 19 "candidate astronauts" still have to qualify for selection to the corps. They include both pilot-astronauts and astro-scientists. That leaves 27 fully-fledged astronauts, 11 of whom have already flown into space.

NASA chose a group of astronauts as early as 1959. They were the famous "Mercury 7" team, who made the first flights into space. The second group of astronauts was chosen in September 1962. One of these men was John Young, who will be commanding the first shuttle flight.

This will be his fifth spaceflight. He first made a space trip in 1965 on the first manned Gemini spacecraft, and then commanded Gemini 10 a year later. During this flight he docked with a target vehicle in Earth orbit while rehearsing for a Moon flight. Next, in 1969, he flew around the Moon on a lunar landing rehearsal flight called Apollo 10.

In April 1972 he actually walked on the Moon during the Apollo 16 mission and drove around in a lunar roving vehicle. John Young is by far the most experienced of the astronauts and it will not be surprising to find him commanding the first shuttle test flight.

John Young is the only active astronaut left from that second group chosen in 1962. A year later NASA selected 14 new pilot-astronauts and many of these flew to the Moon. Like Young, only one remains active. He is Alan Bean. It took Bean six years to get on to a flight crew, but when his time came it was for an im-

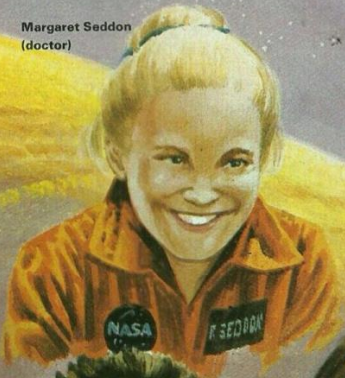
portant mission; the second manned landing on the Moon.

Bean walked on the Moon and collected pieces of equipment from an unmanned lunar lander, Surveyor 3, which had touched down on the Moon two years earlier.

After this Apollo 12 mission, Alan Bean commanded the Skylab 3 mission, which in 1973 took him and two fellow astronauts to the Skylab space station in which they stayed for a record 59 days. Bean has not yet been named for a shuttle flight, but is likely to command one of the earlier operational missions, perhaps Spacelab 1.

The first astronaut-scientists to be selected by NASA joined the Corps in 1965. Originally there were six of them, all trained as pilots. Eventually only four remained, one of them

Margaret Seddon
(doctor)



Judith Resnik (electrical engineer)

Sally Ride (physicist)



Three of the women "shuttle-naughts" being trained as mission specialists. Besides pursuing their own specialist subject, the girls are fully-trained jet pilots and navigators. They are also studying astronomy, celestial mechanics, spacecraft-design and materials, life sciences and space shuttle systems.



One of the tasks for which specialists are trained is the inspection in orbit of the shuttle's heat-absorbing tiles. They must also be able to repair any damaged areas before the craft can make its re-entry into the atmosphere. During this, the most exposed areas glow white hot for a brief time.

becoming the first geologist on the Moon.

The remaining three were the science pilots on the Skylab space-station missions in 1973 and 1974. The first was Dr Joe Kerwin, who stayed in space for 28 days, and the second was Dr Owen Garriott, who flew with Bean on Skylab 3, and who is one of the mission specialists for the Spacelab 1 flight. Dr Edward Gison was the final Skylab science pilot, remaining in space for a record 84 days.

A year later, in 1966, NASA chose 19 more astronauts, an astro-scientist and 18 pilots. Of this group, only eight remain in the corps, and of the eight, three are to command the second, third and final shuttle test flights.

The second commander will be Joe Engle. He was a most promising young pilot who was chosen as the lunar module pilot of Apollo 17. But he was replaced by geologist astro-scientist Jack Schmitt, and thus lost his chance to visit the Moon in 1972. Neither was he included in a Skylab flight. So, with three X-15 rocket plane flights that he made into near space before he joined the astronaut corps behind him, Engle is raring to go.

The next commander is likely to be Vance Brand. He was the Apollo 18 command module pilot who docked with the Soyuz 19 spacecraft during the much-acclaimed joint US-USSR mission in 1975.

The fourth commander will be Jack Lousma, who was the pilot of the second Skylab space station mission. The astro-scientist in the group, Don Lind hopes soon to make a flight as a mission specialist.

Four more of that group of 1966 astronauts, called Group 5, are Tom Mattingly, who was command module pilot of the Apollo 16 flight in 1972, Bill Pogue who was pilot on Skylab 4 and Paul Weitz, the pilot on the Skylab 3 mission.

mission. These and the unlucky Bruce McCandless, never chosen for a flight, are likely to make up the pool of pilots for earlier shuttle operational missions.

A very unlucky group of astro-scientists was chosen in 1967. There were eleven and they never flew. They were called the Excess 11. Now, 13 years later, six of them are grimly hanging on to the hope of a mission specialist's position on an early operational flight.

One looks certain to fly, with another mission specialist, Owen Garriott, on Spacelab 1. He is astronomer Robert Parker. The other five are Joe Allen, Karl Henize, Story Musgrave, Phillip Lenoir and William Thornton.

Waiting For A Flight

The pilots of many of the early shuttle flights will be taken from the Group 7 astronauts' corps, who were chosen in 1969. These pilots were originally chosen to fly a military space station called the Manned Orbital Laboratory, but the project was cancelled and they were transferred to NASA for a frustrating wait for a chance of flight. The first of this group to fly is Bob Crippen, who will be John Young's pilot on STS 1.

No more astronauts were chosen until 1978. Then a new group was chosen. These were 35 astronaut-candidates who comprise 15 pilots and 20 mission specialists. This group includes the first American women astronauts. They are Dr Margaret Seddon, Dr Anna Fisher, both physicians, and Drs Judith Resnik, Shannon Lucid, Sally Ride and Kathryn Sullivan. Three of the Group 8 astronaut candidates are Negroes; Frederick Gregory, a pilot, and Guion Bluford and Ronald McNair, both mission specialist possibles. Another is a Hawaiian

scientist of Japanese origin, Ellison Onizuka.

On 7th July, 1980, 19 new shuttle astronaut candidates reported for duty at the Houston Space Centre. Eight are pilot astronauts and the remainder will take up mission specialist positions. One of the new mission specialists is William Fisher, whose wife, Anna, was one of the Group 8 astro-candidates.

So there is a possibility that the first husband and wife team will be launched into space soon. Also included in the group is the first astronaut of Hispanic origin, Franklin Chang, who was born in Costa Rica.

There is one more important astronaut in the corps at Houston who has not yet been mentioned. He is one of the most remarkable of astronauts and by the time he makes a flight in the shuttle he could be sixty. He is Deke Slayton, who was chosen as one of the Mercury 7 astronauts in 1959 and was originally selected to make the first US manned orbital flight. This flight became the second orbital attempt, after John Glenn made the first in February, 1962. Just before Slayton was due to make his flight into orbit, he was grounded by doctors because they said he had a "heart flutter". Slayton was grounded not only for Mercury flights, but also for Gemini and Apollo, and it was not until 1975 that he actually got into space as the docking module pilot of the joint US/USSR flight at the ripe old age of 51.

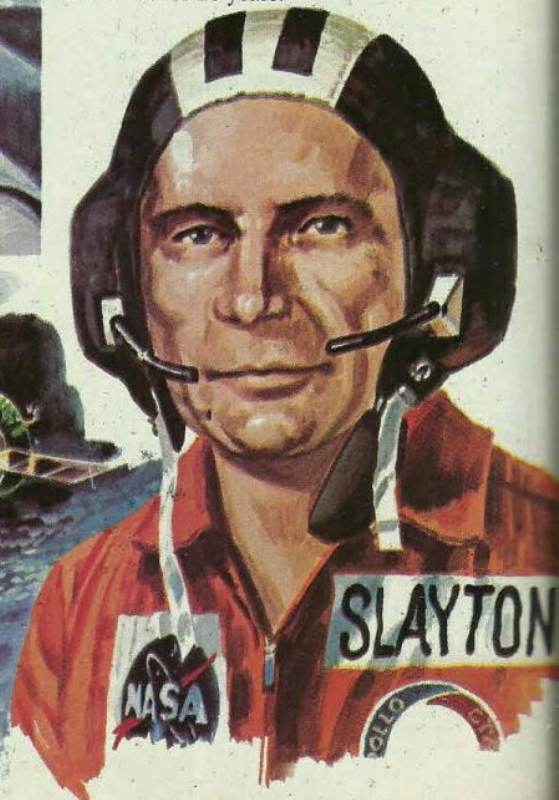
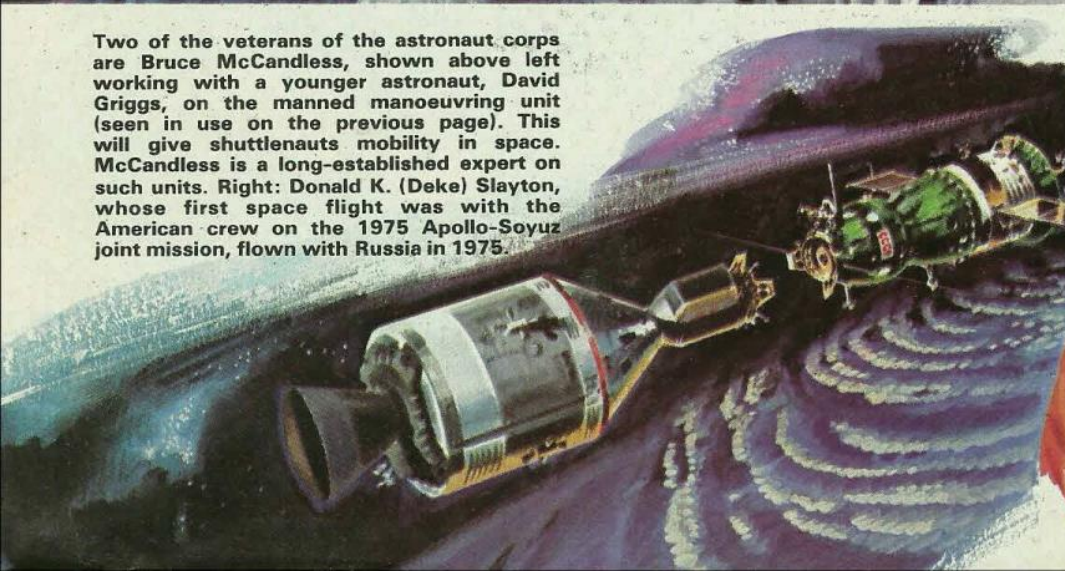
On the Spacelab 1 flight, which is scheduled to be launched on STS 9 in 1982, will be two payload scientists. These two will be chosen from two Americans and three Western Europeans. The Americans are Michael Lampton and Byron Lichtenberg. The three Europeans are a German, Ulf Merbold; an astronomer, Claude Nicollier, from Switzerland, and physicist Wubbo Ockels of Holland.

The Spacelab 2 crew will include two payload scientists who will be selected from four Americans. They are Dr Loren Acton, Dr John-David Bartoe, Dr Dianne Prinz and Dr George Simon.

As there are only about 40 shuttle flights scheduled through the first half of the 1980s, the competition for flight crew positions will be quite intense. But even if some astronauts are not chosen immediately, they may eventually make the trip of a lifetime. After all, it took Deke Slayton 15 years and by the time Bruce McCandless gets up he may have been an astronaut for 20 years.



Two of the veterans of the astronaut corps are Bruce McCandless, shown above left working with a younger astronaut, David Griggs, on the manned manoeuvring unit (seen in use on the previous page). This will give shuttlenauts mobility in space. McCandless is a long-established expert on such units. Right: Donald K. (Deke) Slayton, whose first space flight was with the American crew on the 1975 Apollo-Soyuz joint mission, flown with Russia in 1975.



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No. 982, 3rd JANUARY, 1981.

EVERY MONDAY, PRICE 35p.

WHO WILL WIN . . .

The Great Space Race?

SEE INSIDE STORY on Page 8

Tough Men Of The Timberlands

SEE 'FACT-FINDER' — PAGE 4



DURING the busy space decade of the '60s there were really only two nations actively involved in exploration, America and the Soviet Union dominated the scene. Today it is different. With the commercial advantages that space offers, for example in terms of commercial satellites, America and Russia are not the only nations in space which can offer launching facilities to their customers.

India, China and Britain have all developed satellite launching rockets, but one group of countries in Europe has a rocket that can compete with America and Russia. It is one that has the potential of becoming the most used launch vehicle of the '80s.

The rocket is called Ariane and it has been developed by the European Space Agency. Already it has been booked by an international communications company for the launching of an Intelsat 5 satellite that would normally have been launched by an American booster.

The story of Ariane really goes back to the days before the first satellites had even started orbiting the Earth. In 1955, Britain began the development of an intermediate range ballistic missile, or IRBM for short, called Blue Streak. By 1959, two years into the space age, it was suggested that this rocket could form the first stage of a national multi-stage rocket to put Britain into the space age. However, owing to its extremely high cost, the IRBM programme was cancelled in 1960.

INSIDE STORY

The Great Space Race

Following our features on the American space shuttle we look at . . .

With the American space shuttle encountering technical trouble, Europe is hurrying ahead with the development of its own space launcher

Had more money been available, Britain could have been one of the leading space nations and even sent men into space. Britain even made a second attempt, when it launched its own satellite using its own Black Arrow rocket, but this programme, too, was cancelled in 1971.

Yet Blue Streak lived on. It was to be the first stage of a European satellite launcher, to be developed by the member countries of the newly-formed European Launcher Development Organisation, or ELDO, which was established in 1960.

Blue Streak was to be joined to a French second stage and German third stage to form the Europa rocket.

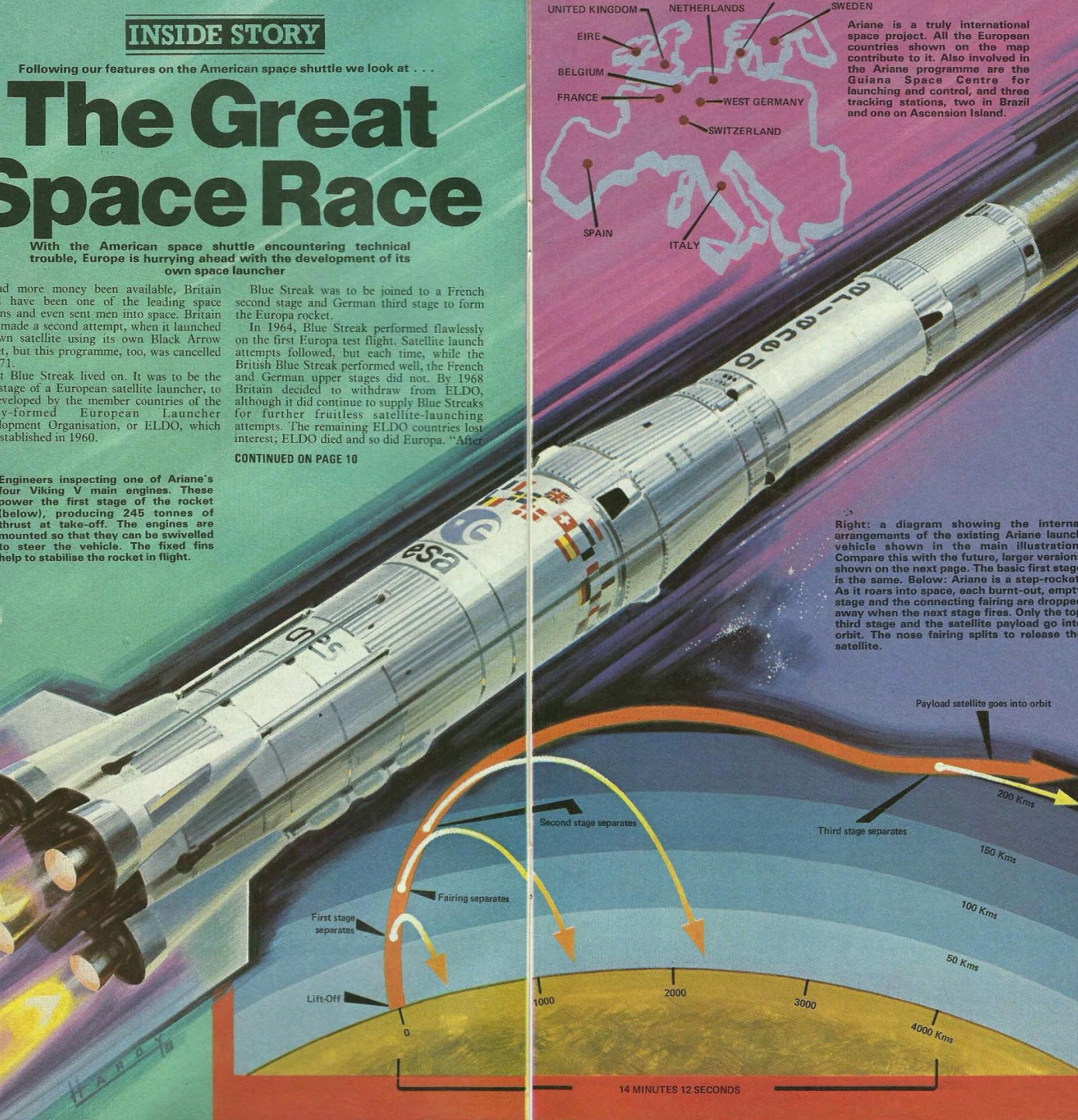
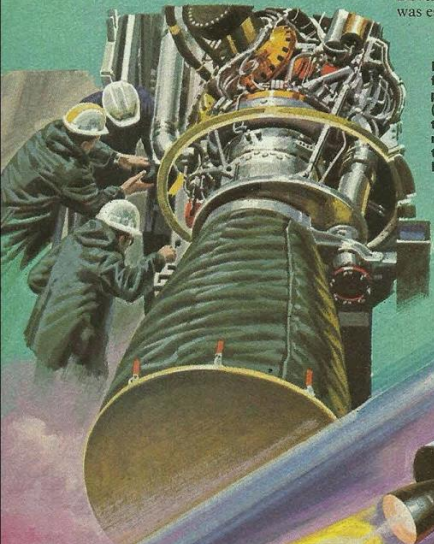
In 1964, Blue Streak performed flawlessly on the first Europa test flight. Satellite launch attempts followed, but each time, while the British Blue Streak performed well, the French and German upper stages did not. By 1968 Britain decided to withdraw from ELDO, although it did continue to supply Blue Streaks for further fruitless satellite-launching attempts. The remaining ELDO countries lost interest; ELDO died and so did Europa. "After

CONTINUED ON PAGE 10

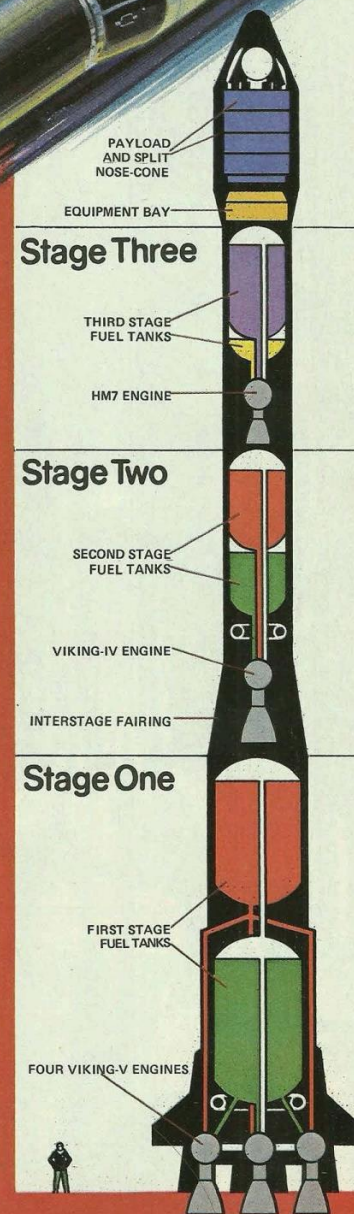
Engineers inspecting one of Ariane's four Viking V main engines. These power the first stage of the rocket (below), producing 245 tonnes of thrust at take-off. The engines are mounted so that they can be swivelled to steer the vehicle. The fixed fins help to stabilise the rocket in flight.



Ariane is a truly international space project. All the European countries shown on the map contribute to it. Also involved in the Ariane programme are the Guiana Space Centre for launching and control, and three tracking stations, two in Brazil and one on Ascension Island.



Right: a diagram showing the internal arrangements of the existing Ariane launch vehicle shown in the main illustration. Compare this with the future, larger versions shown on the next page. The basic first stage is the same. Below: Ariane is a step-rocket. As it roars into space, each burnt-out, empty stage and the connecting fairing are dropped away when the next stage fires. Only the top third stage and the satellite payload go into orbit. The nose fairing splits to release the satellite.





If Europe wanted to develop the ability to fly man in space, what kind of technological effort would be needed? The answer to this question, after a two-year study by Aérospatiale in France is Hermes, the "mini space shuttle" shown above. Shown far left are the two advanced Ariane studies — the Hermes launcher code-named 5/H, and the 5/2.

all," people asked, "did Europe really need its own launcher?"

In the early '70s these European countries developed a communications satellite called Symphonie and asked the United States of America to launch it for them. The US agreed, but on the condition that the use of Symphonie and future European satellites did not jeopardise the commercial future of the Intelsat communications satellite programme, in which the US had a majority share.

Europe at last had a tangible and good reason to have its own, independent launcher, and one that could compete with the US for satellite customers. But ELDO and Europa lay in ruins and the ambitious French plunged ahead with the development of their own launcher, called Vega.

They would have continued in this fashion had not other European countries wished to join with them in a space consortium. The European Space Agency was born in 1973, with Vega becoming the European Ariane launch vehicle. The French were contributing 60 per cent of the cost and Germany 20 per cent. Britain contributes only 2½ per cent.

Ariane can compete with any of its rivals. Apart from being used to launch European satellites, it can provide a launching service for customers who thus do not need to go to the USA or Russia for these facilities.

The American Delta can launch a

communications satellite weighing 900 kg into orbit, the Centaur 1,850 kg. Ariane can launch a payload of 1,780 kg. The American space shuttle, a reusable and versatile spacecraft that will be used to launch satellites quite cheaply, currently has technical problems; so the sooner Ariane is operational, the better for ESA.

Ariane's first flight was completely unheralded, partly because it took place on Christmas Eve in 1979, and partly because of lack of space interest. The rocket's launch from the launch site at Kourou in Guiana was a complete success, and a test satellite was placed into orbit.

Four more flights were needed before the rocket could be declared operational. Unfortunately, the second flight was a failure; and the third flight is not scheduled to take place until early in 1981, at about the time that the space shuttle is due to make its first space appearance.

By improving the performance of Ariane's upper stages and augmenting the thrust of its first stages, with the addition of strap-on solid rocket boosters, ESA is hoping eventually to develop larger versions of the launcher. Ariane 5/H, for example, will be able to launch a two-man space shuttle called Hermes.

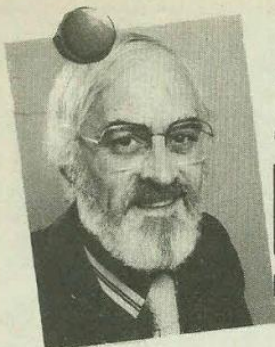
The European Space Agency's Ariane has the potential of being the busiest rocket of the '80s. It is a pity that Britain's share in it is so very small.

The New
Look AND Learn

With World Of Knowledge

**SEE 'FACT-FINDER'
ON PAGE 30.**





HARDY'S

DRAWING BOARD

Ringling The Changes...

This week Wilf Hardy focuses on the Bell XV-15 Tilt-Rotor, which may prove to be the best combination of aeroplane and helicopter



EVEN THE BEST HELICOPTER SUFFERS FROM ITS ROTOR BLADES HAVING TO DO TWO JOBS - LIFTING LIKE NARROW WINGS AND DRIVING FORWARD. THE HIGHEST SPEED OBTAINED IS ABOUT 375 KM PER HOUR.

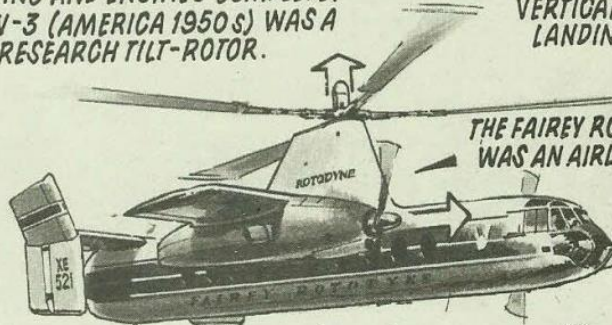
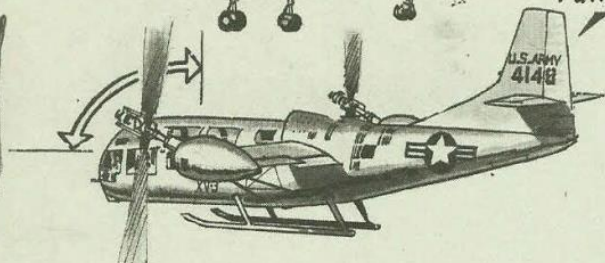


BECAUSE OF THE TWO TASKS THE COMPONENTS IN THE SYSTEM ARE SUBJECT TO VIBRATION AND RAPID WEAR - MAKING THEM COSTLY TO FLY AND MAINTAIN.

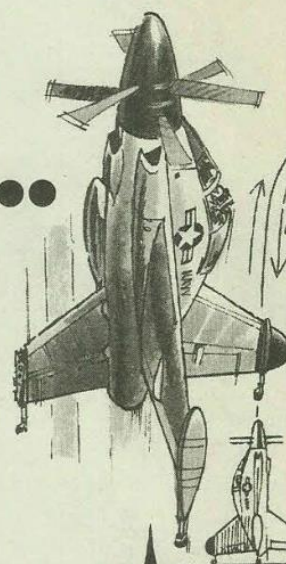
SO DESIGNERS HAVE FOR YEARS SOUGHT TO GO UP AND DOWN VERTICALLY BUT FLY FASTER IN BETWEEN...

CANADAIR CL-84 (CANADA 1960s) TILTED ITS WHOLE WING AND ENGINES COMPLETE.

BELL XV-3 (AMERICA 1950s) WAS A PURE RESEARCH TILT-ROTOR.



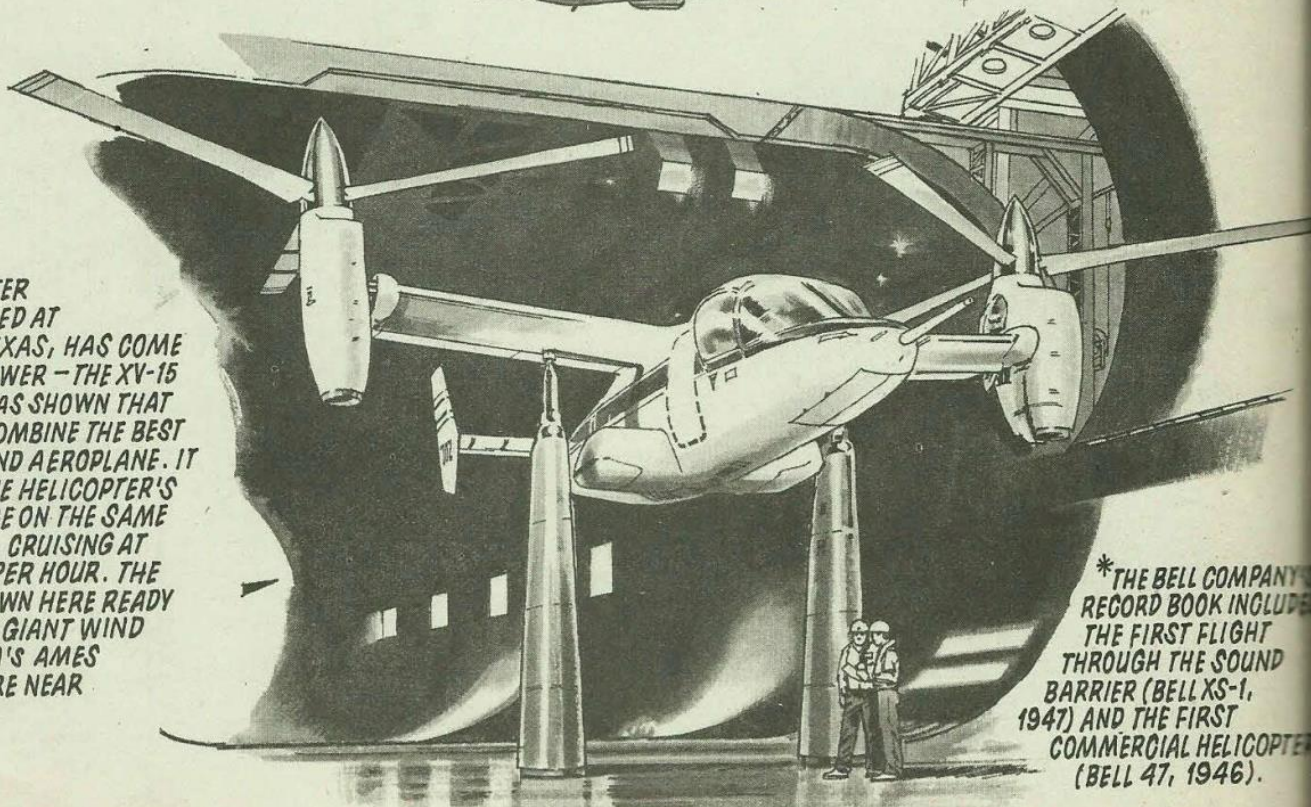
THE FAIREY ROTODYNE (BRITAIN 1950s) WAS AN AIRLINER DESIGN USING A ROTOR, AND FORWARD-PROPULSION ENGINES MOUNTED ON STUBBY WINGS.



NICKNAMED "POGO", AFTER THE SPRINGY BOUNCING TOY!

THE CONVAIR XFY-1 (AMERICA 1950s) WAS A "PROP-HANGER" - LITERALLY HANGING, UNDER ITS PROPELLERS' THRUST, FOR VERTICAL TAKE-OFF AND LANDING.

THE BELL HELICOPTER COMPANY*, BASED AT FORT WORTH IN TEXAS, HAS COME UP WITH THE ANSWER - THE XV-15 TILT-ROTOR. IT HAS SHOWN THAT IT REALLY DOES COMBINE THE BEST OF HELICOPTER AND AEROPLANE. IT OFFERS TWICE THE HELICOPTER'S SPEED AND RANGE ON THE SAME AMOUNT OF FUEL. CRUISING AT ABOUT 540 KM PER HOUR. THE AIRCRAFT IS SHOWN HERE READY FOR TESTS IN THE GIANT WIND TUNNEL AT NASA'S AMES RESEARCH CENTRE NEAR SAN FRANCISCO.



*THE BELL COMPANY'S RECORD BOOK INCLUDES THE FIRST FLIGHT THROUGH THE SOUND BARRIER (BELL XS-1, 1947) AND THE FIRST COMMERCIAL HELICOPTER (BELL 47, 1946).

THE XV-15'S ENGINES ARE TWO LYCOMING TURBOSHAFTS — EACH DELIVERING 1,550 HORSEPOWER. THEY ARE LIKE MINIATURE JET ENGINES, BUT USED TO SPIN PROPELLERS

INSIDE THE WING IS THE SHAFT LINKING ONE ENGINE WITH THE OTHER THROUGH A SMALL GEARBOX IN THE CENTRE.

THESE BOXES "MIX" THE ROTOR CONTROLS AS THE AIRCRAFT CHANGES FROM HELICOPTER TO AEROPLANE.

FORWARD FLIGHT FROM HOVER TO ACCELERATING FORWARD CAN BE ACHIEVED IN 12 SECONDS, OR THE PILOTS CAN SELECT A "SLOW" RATE TAKING 1 MINUTE. THE XV-15 IS NOW AN AEROPLANE BEING THRUST ALONG BY LARGE PROPELLERS, USING NORMAL WING AND TAIL CONTROL SURFACES.

TRANSITION FROM HELICOPTER HOVERING BEGINS AS THE ENGINES AND ROTORS TILT DOWNWARDS. THIS PROCESS CAN BE STOPPED OR STARTED AGAIN IN FLIGHT WITH NO TROUBLE WHATSOEVER.

THE 200°C TEMPERATURE OF THE EXHAUST JET IS COOLED BY THE POWERFUL DOWNWASH OF THE ROTOR — SO IT WON'T MELT THE AIRPORT TARMAC!

AN IMPORTANT SAFETY DEVICE IS THE LINKING OF THE TWO ENGINES, SO THAT BOTH ARE DRIVING BOTH ROTORS ALL THE TIME — IF ONE ENGINE STOPS, THE OTHER KEEPS THE PLANE FLYING.

IN THE SAME WAY THAT THE ENGINES ARE CONNECTED, SO ARE THE TILTING MECHANISMS, THUS ENSURING THAT BOTH TILT AT EXACTLY THE SAME TIME, SPEED AND ANGLE.

ROTOR TILTING MECHANISM.

HOVERING AND VERTICAL TAKE-OFF OR LANDING WORKS JUST LIKE A HELICOPTER, BUT IS SMOOTHER AND QUIETER.

AUTOROTATION PROVIDES THE ULTIMATE SAFETY FACTOR. IF BOTH ENGINES FAIL, THE ROTORS AUTOMATICALLY SWING UP INTO THE HELICOPTER POSITION AND THE AIRFLOW KEEPS THE ROTORS SPINNING, WITHOUT POWER, FOR A SAFE LANDING.

NATURE'S OWN "AUTOROTATER" — THE WINGED FRUIT OF THE SYCAMORE TREE SPINS DOWN ON THE WIND.

A COMMERCIAL DESIGN BASED ON THE XV-15 IS THE BELL D326 "CLIPPER" WHICH WOULD CARRY 30 PASSENGERS BETWEEN CITY CENTRES OR OUT TO OIL RIGS.

The New **Look AND Learn**

No. 992, 14th MARCH, 1981. EVERY MONDAY PRICE 40p.
Australia 50 cents, New Zealand 50 cents, Canada 70 cents,
Malaysia \$2.25.

With **World Of Knowledge**

The Cod That Caused A War

SEE FACT-FINDER — INSIDE



THE World of Knowledge

SECTION

THIS MODERN AGE

Is There A Future For The Skyship?

Enormous airships, some shaped like discs and others with cigar-like forms, are being planned as the cargo and passenger carriers of tomorrow

DISC-SHAPED airships, looking like flying saucers, could be carrying people and goods in and out of London and other big cities in a few years, providing sufficient money can be raised to finance their production. For the technology for building them exists. And with the use of helium, which does not catch fire, instead of hydrogen, which is highly inflammable, the airships are likely to be much safer than earlier types.

Airships seemed to have a promising future until the late 1930s, when a number of disastrous fires, with a large loss of life, stopped production. Now they are again being put forward as alternatives to road, rail, sea and air transport, principally for carrying freight.

In a report published last year, the Greater London Council spoke of plans being made for the test flights of a cargo vessel and another intended for carrying 70 passengers. They would be built, the report said, at a plant in London's derelict dockyards area. A giant terminal could be established nearby.

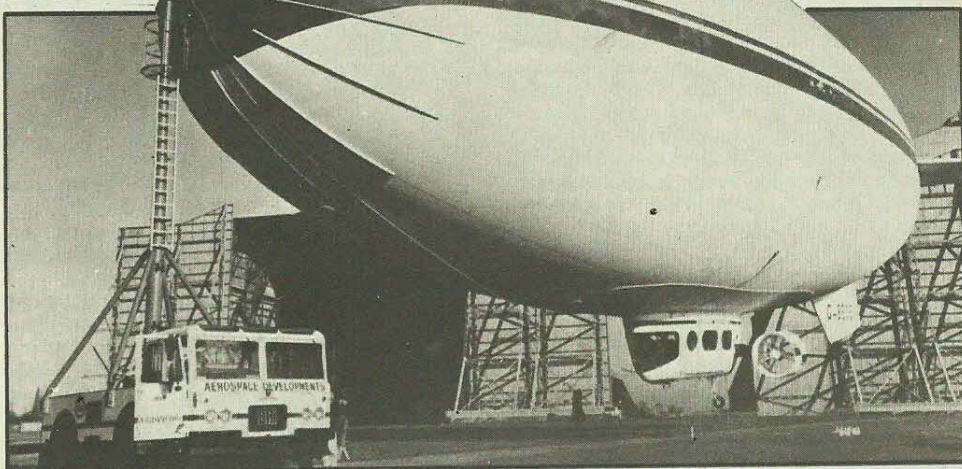
All this, however, depends upon enough money being raised to pay for it. A company interested in the project estimated that £30 million would be needed to get the scheme going, and without State aid the project was unlikely to get off the ground.

However, if all goes well, what would we be likely to see? The experts say that the airship, in addition to being safe, is ideal for carrying cargoes, because it is easy to load.

Airships are expected to take off and land on a circular pad covering four hectares. At anchorage points around the edge, airships would be attached to hawsers fixed to winches on each vessel. At landings or take-offs, the winches would enable the airships to be lowered to or raised from the pad.

The goods to be carried would be pre-packed in containers, and bays for loading and unloading these containers would be set up near the airships' ports. Around the port would be cranes, fork-lift trucks and other machinery to make the loading and unloading as smooth and efficient as possible. The first bases could be built near motorways.

The safety precautions to be taken in constructing the vessels would include dividing them into separate compartments. Should a fire break out, it could be stifled by filling the compartment with helium.



Trips to the Isle of Man could start with a ride in the saucer-shaped balloon (top) being planned by a Manx company. The airship above was the first commercial model built in Britain for 40 years. It can lift 2.5 tons of freight, or carry 12 people.

As airships do not rely upon their engines to remain airborne, the failure of one or more engines would not hazard the craft, but merely result in the loss of speed. It is anticipated that the engines could be repaired while the craft is in the air, a complete set of spares and tools being carried. A spare engine may be carried as a standby.

As the craft would be controlled from a flight deck manned by several officers, it would never be entirely in the hands of one man. This would minimise the effect of pilot error.

As well as being suitable for pleasure cruises, the airship could be used as a car ferry or for transporting engineering plant. Machinery, site

materials and prefabricated buildings could be carried to places which other forms of transport are unable to reach.

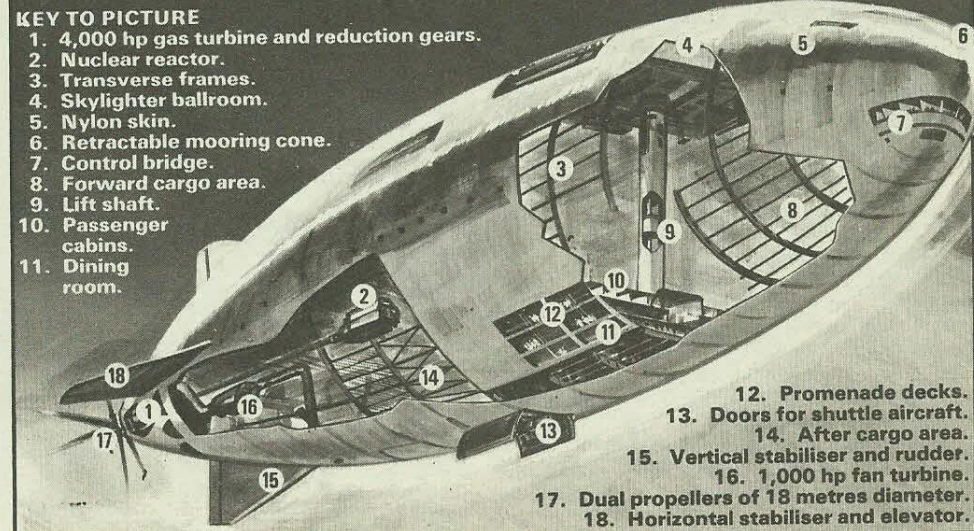
Military experts are looking for ways in which they can use airships. One large airship could convey a quantity of aircraft, hundreds of men, vehicles and stores. Navies would find them useful for anti-submarine activities, for airships can search for submarines and attack them from the air.

The use of nuclear power for some of these airships has been forecast, and this could certainly prove to be a significant step. Only time, however, will reveal the role that the airship is destined to play in the future.

This nuclear airship was designed by engineers at Boston University in the USA. Flying at 160 km/hr, it would have a virtually unlimited range. As a commercial craft, it could carry 400 passengers and 150 cars.

KEY TO PICTURE

1. 4,000 hp gas turbine and reduction gears.
2. Nuclear reactor.
3. Transverse frames.
4. Skylighter ballroom.
5. Nylon skin.
6. Retractable mooring cone.
7. Control bridge.
8. Forward cargo area.
9. Lift shaft.
10. Passenger cabins.
11. Dining room.



12. Promenade decks.
13. Doors for shuttle aircraft.
14. After cargo area.
15. Vertical stabiliser and rudder.
16. 1,000 hp fan turbine.
17. Dual propellers of 18 metres diameter.
18. Horizontal stabiliser and elevator.

The New **Look** AND **Learn**

No. 999, 2nd MAY, 1981. EVERY MONDAY PRICE 40p.

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The Magnificent Mikados Of Japan

SEE FACT-FINDER
— PAGE 30



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THE LONG~ RANGE LASER

A British observatory plans to link the latest laser-ranging equipment with a satellite orbiting 6,000 kilometres above the Earth

THE Royal Greenwich Observatory in London and the University of Hull are working together to develop a laser-ranging station for satellites which should be installed at the Herstmonceux Observatory in East Sussex later in 1981. This will be able to measure the distance to artificial satellites 6,000 kilometres above the Earth's surface to within 10 centimetres, and give information on the way they move in their orbits.

Another important study will be the detection of very small changes in the rotation of the Earth. The results will help us to understand the movements and properties of material under the Earth's crust and are likely to be useful in the study of weather systems and the oceans.

By measuring the distance between this ranging station and similar installations in other countries, accurate to a few centimetres, we can investigate the way in which the continents are slowly drifting apart. This may help in the prediction of earthquakes.

The main satellite to be used for observations is called *Lageos*. It was launched by NASA in 1976, and is a heavy metal sphere, 60 centimetres in diameter. *Lageos* has no electronics, gyroscopes or rocket motors which could fail, and no solar panels which might reflect sunlight unevenly and make its orbit less predictable. Its motion is controlled solely by gravitational forces, and so can be used to examine these forces.

The ranging system works like radar, but instead of bursts of radio waves it uses very short pulses of green laser-light. The transmitting telescope sends the light out in a narrow beam towards the predicted position of the satellite, which is studded with carefully designed retro-reflectors. These reflect practically all the light striking them back in the direction from which it came.

This reflected light is collected by the receiving telescope and activates a photomultiplier tube, producing a sharp electrical pulse. This is used to stop an electrical timer that was started when the laser beam was sent out. Our large illustration shows how this system is arranged.

The distance is calculated from the time that the light

takes to make the round trip, measured to within about one ten-thousandth of a millionth of a second! By the time the pulse of light reaches the satellite it will have spread out into a rather patchy "pancake", a few hundred metres across but only about five centimetres thick. The next pulse comes about one-tenth of a second later.

Because the light spreads out to cover an area much larger than the satellite, only a small fraction of the original light is returned towards the telescope. When it reaches the Earth's surface again, even this light has spread out to cover a patch perhaps a kilometre across. The receiving telescope, only half a metre in diameter, collects only a small fraction of the energy sent out.

Computer Control

Therefore, many precautions have to be taken to reduce the number of false detections; for example, the detector responds only to light of exactly the right colour, and is connected to the timer for only about a millionth of a second around the expected time of the pulse's return. The aiming of the telescope will be precisely controlled by a computer, and will be checked from time to time by pointing it at stars whose positions are known exactly.

An atomic clock will be used to fix the time at which each measurement is made. All laser-ranging stations have to keep their clocks in step to about a millionth of a second so that their results can be successfully combined.

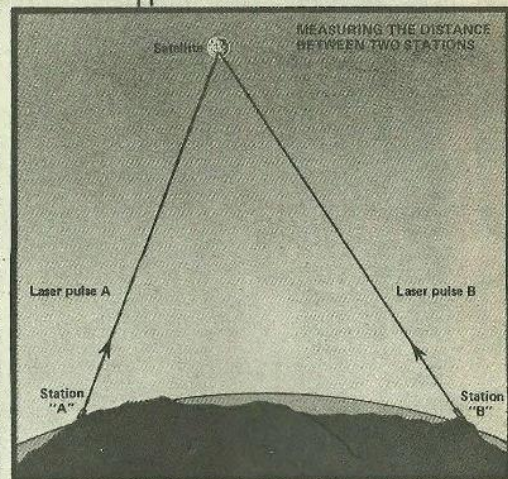
As with most systems involving lasers, there are safety precautions, although the laser will not be extraordinarily powerful. In fact, the total power is less than that from a small domestic lamp, but its light could be focussed into a spot less than one-hundredth of a millimetre across the back of the eye. This might damage the eyes of anyone looking down the beam from an aircraft, and so a wide-range radar set is mounted near the telescope; this is controlled to follow the telescope's direction, and will automatically switch off the laser if it detects an aircraft about to fly near the laser beam.



THE LASER-SATELLITE RANGING SYSTEM

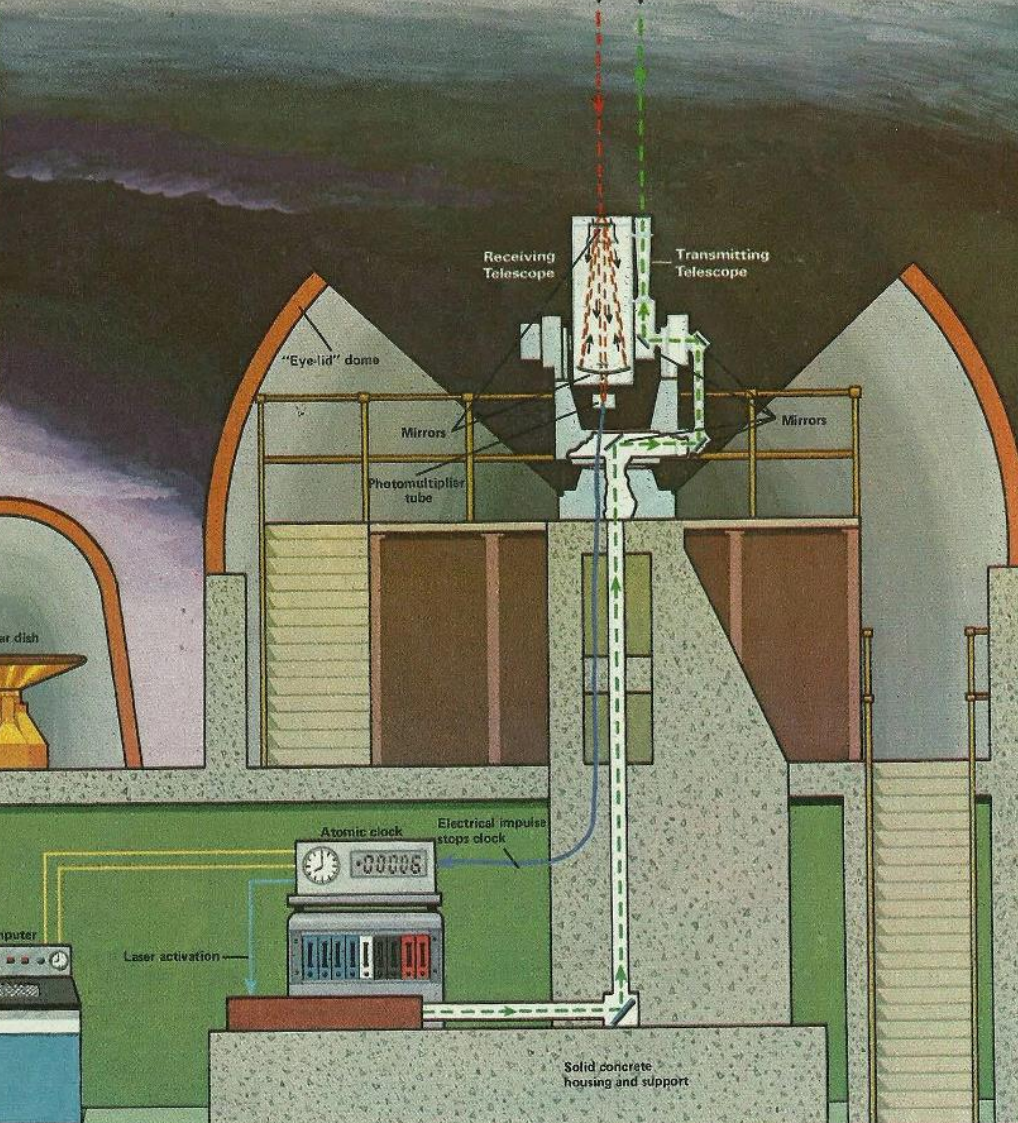
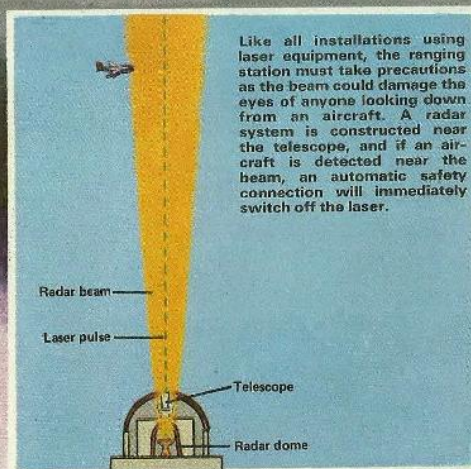
Retro-reflectors
Lageos satellite
Laser pulse reflected

By firing a laser impulse from two stations and determining the distance of the station from the satellite, the distance between the two stations can be calculated. This will provide information on "continental drift" to see how fast the continents are moving apart, and may help scientists to predict earthquakes.



Path of reflected pulse
Path of transmitted laser pulse

Illustrated by Wendy Meadway



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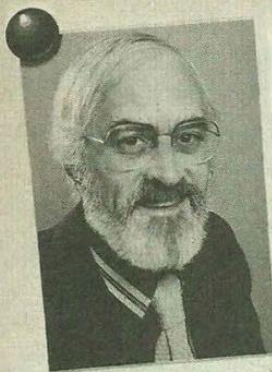
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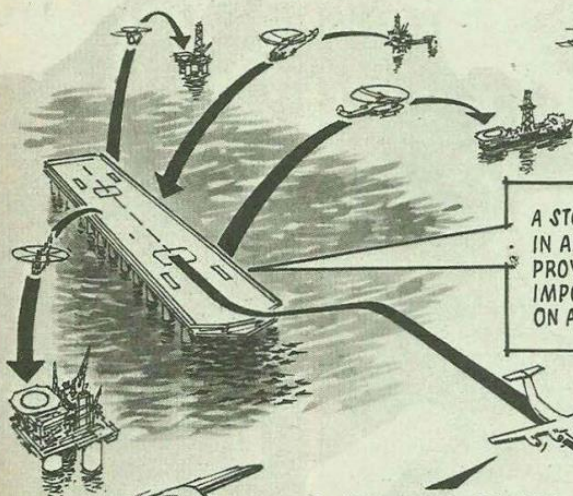
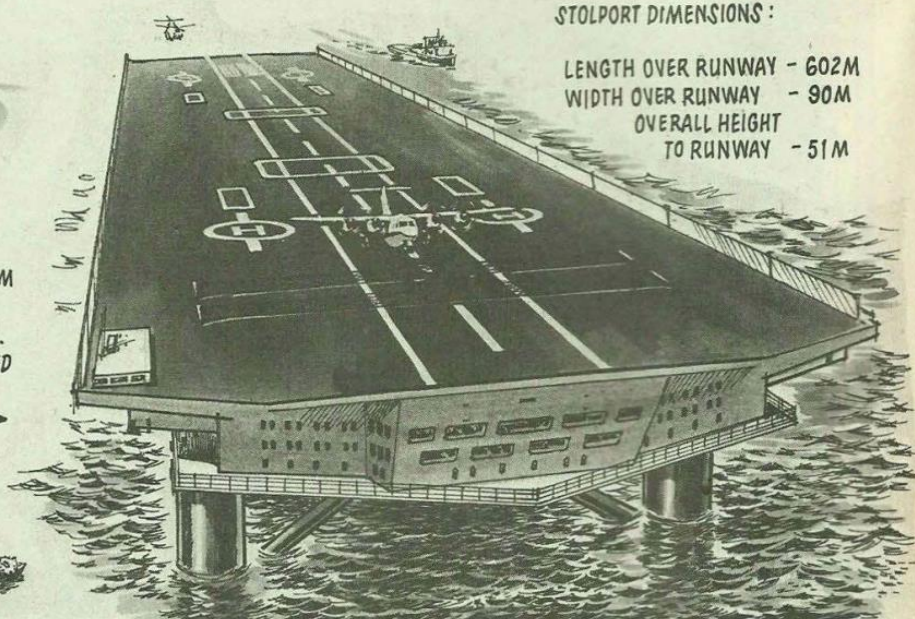
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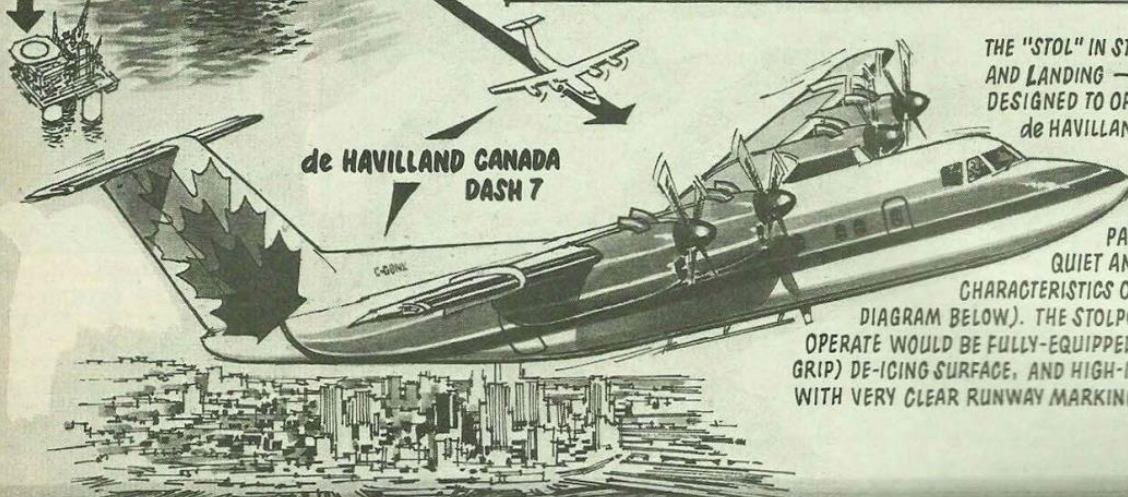
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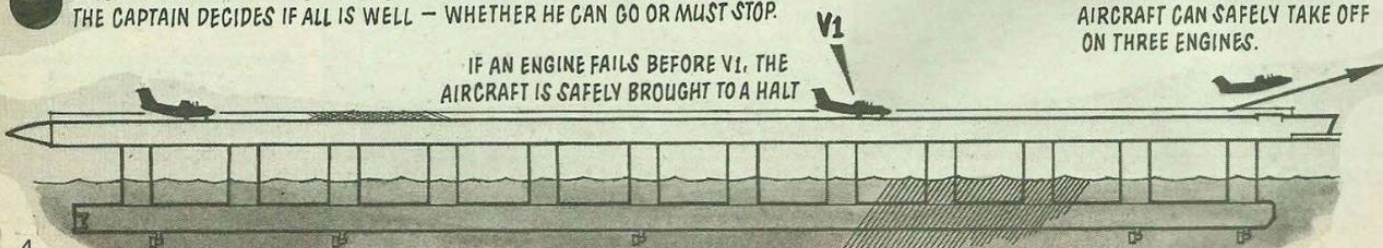
THE "STOL" IN STOLPORT STANDS FOR **SHORT TAKE-OFF AND LANDING** — A TERM USED TO DESCRIBE AIRCRAFT DESIGNED TO OPERATE FROM SHORT RUNWAYS.

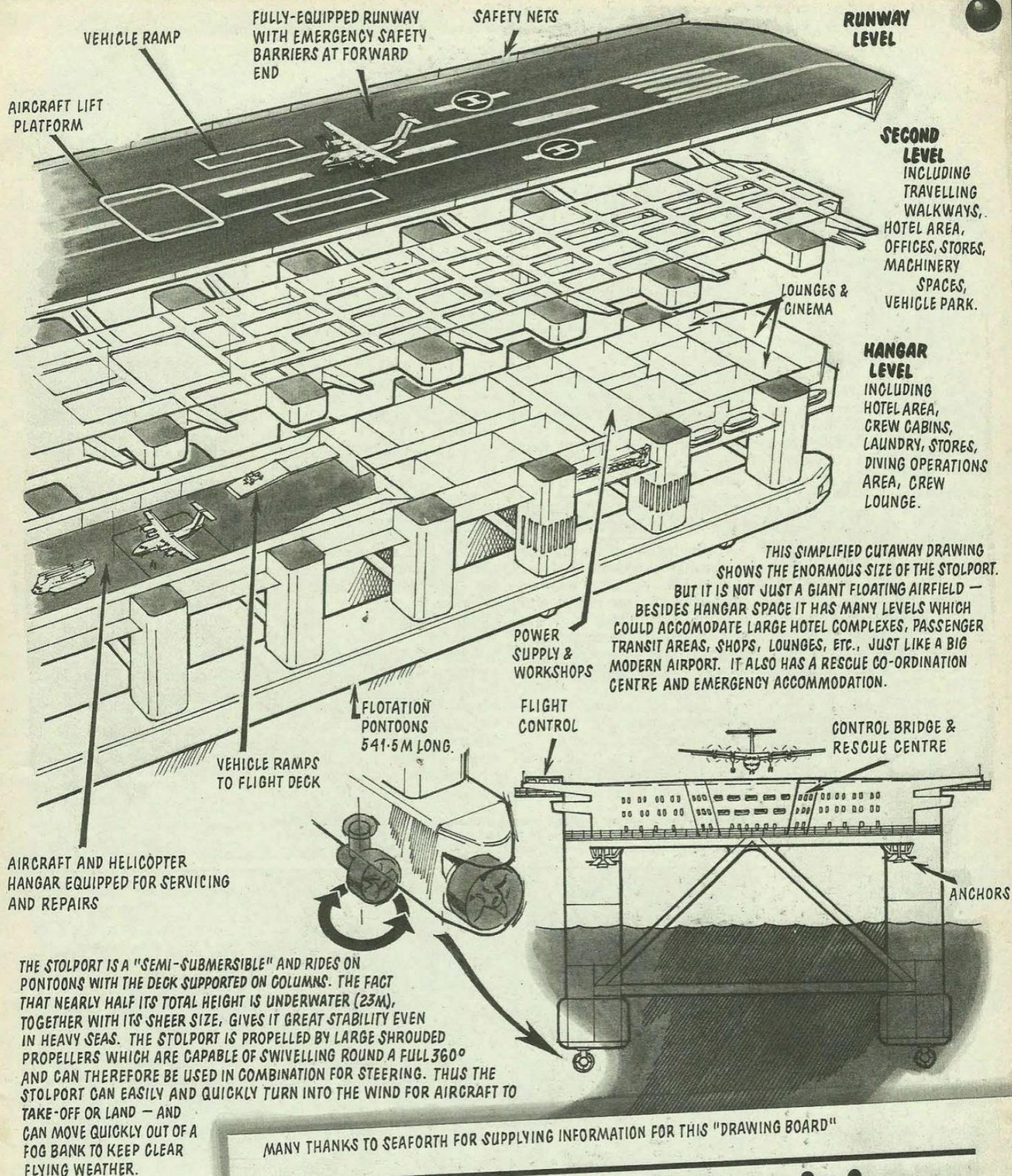
de HAVILLAND CANADA ARE EXPERTS IN THIS FIELD AND THEIR "DASH 7" IS IDEAL FOR FLYING OILMEN OUT TO A FLOATING RUNWAY. IT CARRIES FIFTY PASSENGERS. THIS EXCEPTIONALLY QUIET AND CAPABLE AIRCRAFT HAS SAFETY CHARACTERISTICS OF A HIGH ORDER (SHOWN IN THE DIAGRAM BELOW). THE STOLPORT RUNWAY FROM WHICH IT WOULD OPERATE WOULD BE FULLY-EQUIPPED WITH A HIGH-FRICTION (FIRM GRIP) DE-ICING SURFACE, AND HIGH-INTENSITY LIGHTING COUPLED WITH VERY CLEAR RUNWAY MARKINGS.

DASH 7 SAFETY — "V₁" IS THE SPEED AND POINT IN A TAKE-OFF WHEN THE CAPTAIN DECIDES IF ALL IS WELL — WHETHER HE CAN GO OR MUST STOP.

IF AN ENGINE FAILS BEFORE V₁, THE AIRCRAFT IS SAFELY BROUGHT TO A HALT

IF AN ENGINE FAILS AFTER V₁, THE AIRCRAFT CAN SAFELY TAKE OFF ON THREE ENGINES.





MANY THANKS TO SEAFORTH FOR SUPPLYING INFORMATION FOR THIS "DRAWING BOARD"

Seaforth Maritime
NEWSNEWSNEWS
 Newspaper of Seaforth Maritime Limited. **Issue no.22**

THE STOLPORT IS BEING CLOSELY EXAMINED FOR USE IN U.K., CANADIAN AND NORWEGIAN WATERS. OTHER POTENTIAL AREAS INCLUDE THE GULF OF MEXICO, ARGENTINA AND OFF WESTERN AUSTRALIA.

In less than a decade Seaforth has from what it is today. It is probably foolhardy to attempt to describe

£1000 COMPETITION - Details Inside

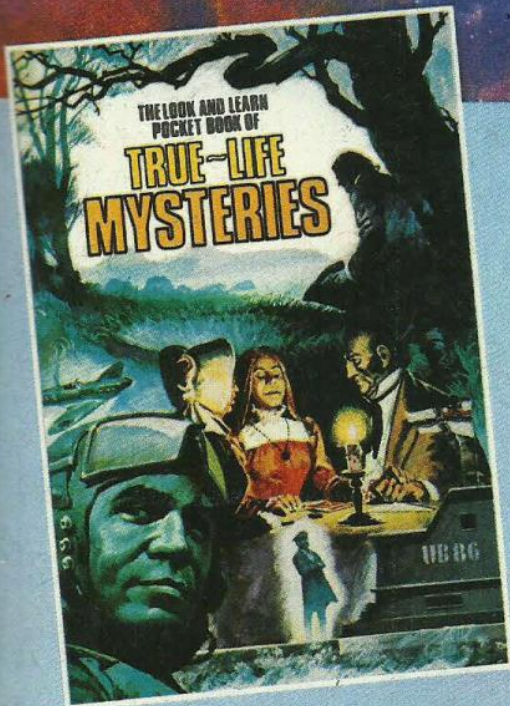
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WHAT NEXT IN SPACE?

The recent launch of the American Space Shuttle, and its dramatic return to Earth, awakened a new interest in space. In this series we will be looking at some of the benefits that space exploration can give to the world and we will also be examining future developments that have followed . . .

CARMAKERS have known for some time about a certain metal alloy, or mixture of metals, which could extend a vehicle's life and which is lighter and stronger than steel; and being lighter would also save dramatically on fuel consumption. Why have not they used it? Simply because it cannot be made on Earth. The combination of metals required will not "mix" because of the pull of Earth's gravity. But it could be produced in the gravity-free environment of space, and is one of the many exciting possibilities being examined following the first successful flight of Space Transportation System 102, otherwise known as the Space Shuttle *Columbia*.

The stubby-winged orbiter, which blasted off from the Kennedy Space Centre in Florida on 12th April this year and glided in to a perfect landing at Edwards Air Force Base, in California's sunbaked Mojave Desert, after completing 36 orbits in 54 hours, 20 minutes and 58 seconds, ushered in a spectacular new era in man's conquest and exploitation of space.

Not only were astronauts John Young and Bob Crippen the first Americans in space for nearly six

The Great Shuttle Success

years (the last being the Apollo crewmen who linked up with the Russian Soyuz 19, in July, 1975), but for the first time ever a manned space vehicle had returned which would be used again, up to a hundred times again, in fact . . . and that is the reason why the Shuttle has already been called "the key to opening the next industrial revolution".

To get some idea of the size and scope of this new American enterprise, it should be realised that NASA (the National Aeronautics & Space Administration) and the United States Department of Defense are planning between

them no less than 487 manned missions between now and 1991.

Compare this with the grand total of 85 manned space flights, both American and Russian, since the late Yuri Gagarin made his historic orbit in April, 1961, up until the end of last year, and it becomes obvious that manned spaceflight is shifting up through several gears.

Furthermore, the sheer carrying capacity of the Shuttle puts it in another league. No manned space vehicle has ever carried up more than three people at once, whereas Shuttle will be able to carry up to seven (a crew of two, and up to

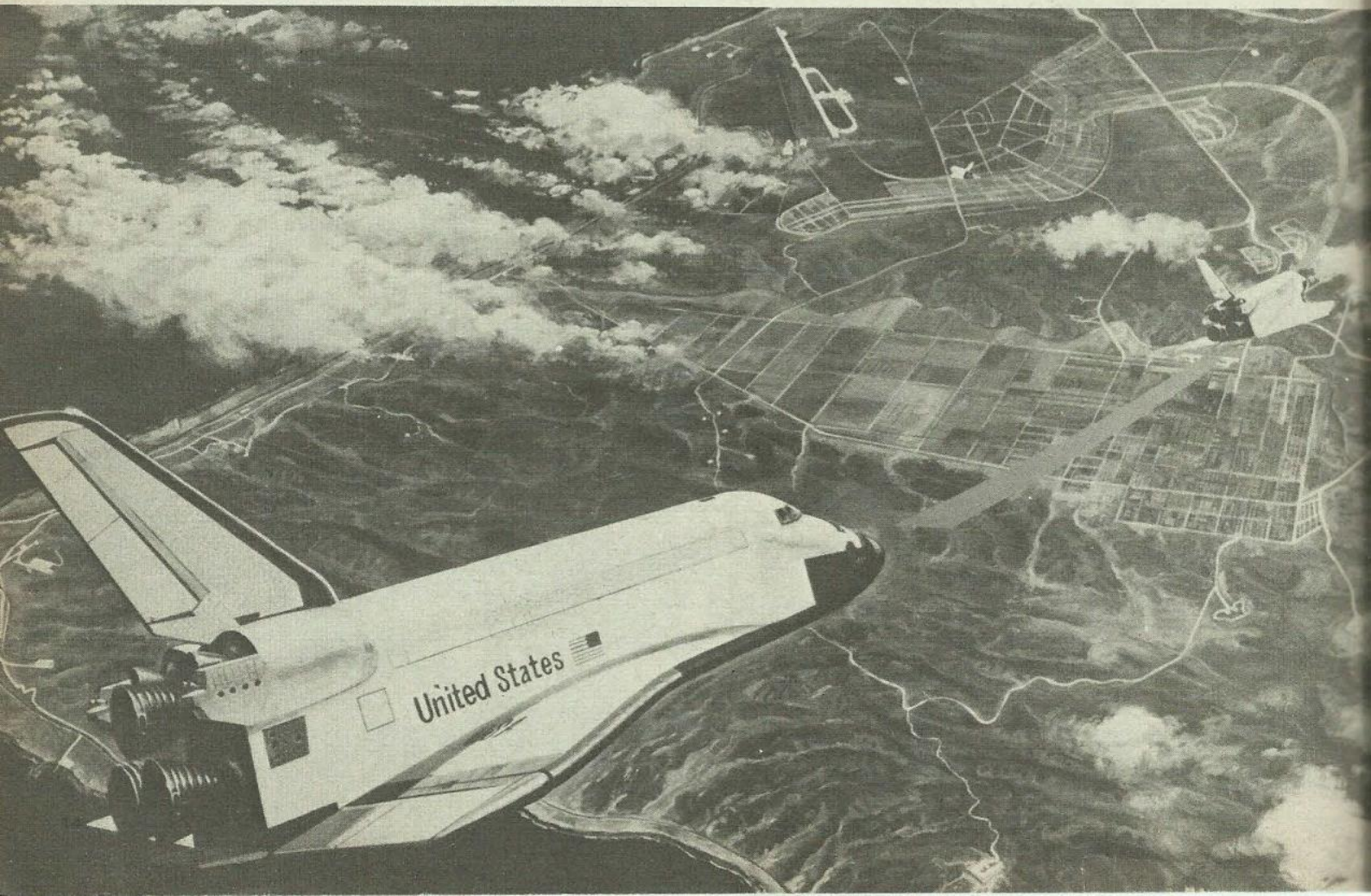
five mission specialists), along with a cargo payload of up to 30 tonnes when launched into an equatorial orbit (or 16 tonnes when launched into a Polar orbit) . . . and bring it all back down again, if necessary.

At present, NASA is building three more Shuttles: Orbiter 099, originally built as a ground-based testbed but being upgraded for spaceflight, and to be named *Challenger*; and Orbiters 103 and 104, to be named *Discovery* and *Atlantis*, respectively. Orbiter 101, the *Enterprise*, which was used for approach and landing tests during 1977, is unsuitable for conversion and will probably be broken up to supply spare parts for *Discovery* and *Atlantis*. A fifth, as yet unnamed, Shuttle, has still to be funded by the US Government, but will almost certainly be authorised next year, for completion in 1987.

It is the flexibility, economy, and cargo capacity of Shuttle which give it such staggering implications for all our futures. Broadly, Shuttle's uses can be placed in three main categories; commercial, scientific, and military.

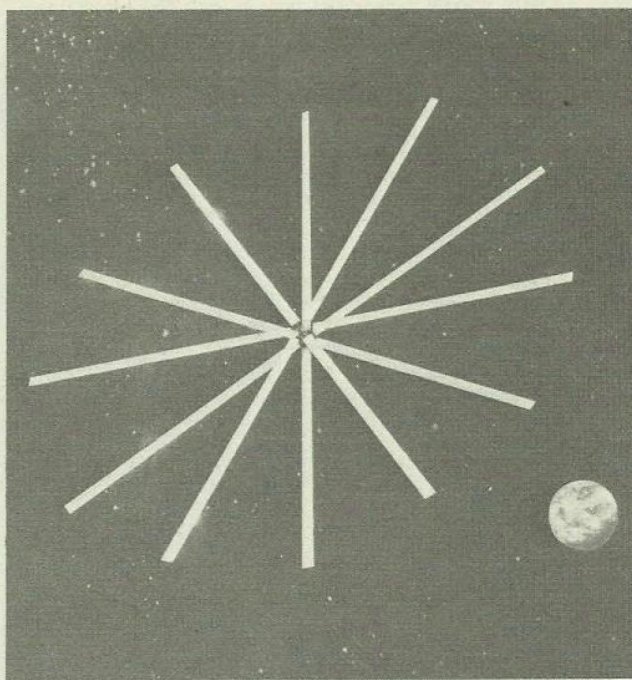
One of its possible commercial uses has already been mentioned, the production of alloys impossible

The Space Shuttle — has its success heralded a new industrial revolution?





The Kennedy Space Centre, Florida, is dominated by the Vehicle Assembly Building. It is the most capacious scientific building in the world (see *Fact-Finder*, page 21). Right: Not a giant asterisk floating in the sky but an artist's impression of a spinning solar sail, one of the ideas put forward for a craft which could rendezvous with Halley's Comet when it approaches the Earth in 1986.

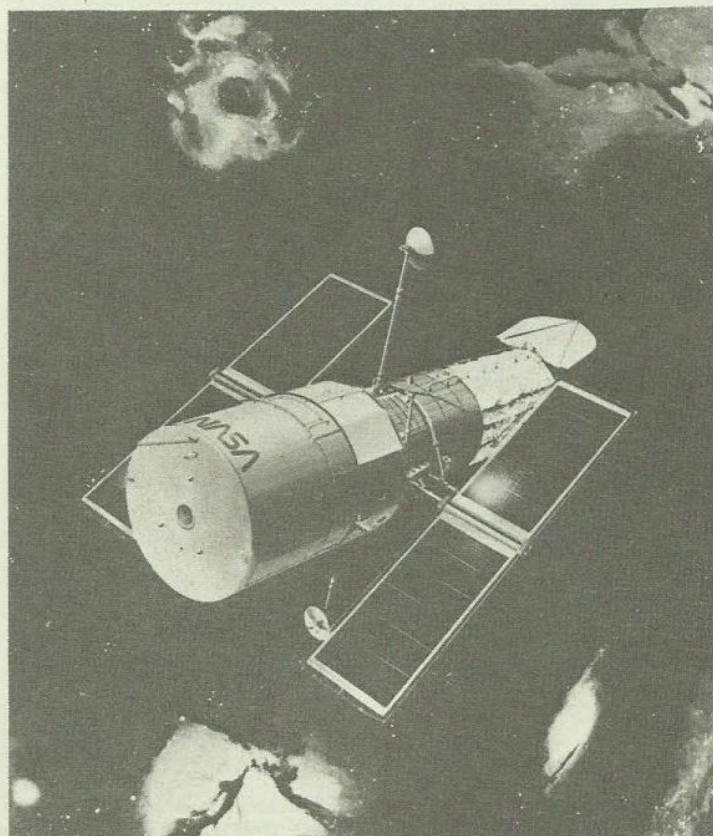


to make on Earth. This also applies to a wide range of other products, notably pure glass for use in laser, optical, and electronic equipment; and equally pure, and consequently far more effective, drugs for fighting disease.

Its ability to place in orbit, maintain, and bring down if necessary, large and complex satellites will accelerate the revolutions already beginning in global communications, navigation, weather forecasting, land use and crop disease control, and exploitation of mineral and energy resources. And NASA are confident that by the end of the decade small wrist radios linked into the satellite network will enable anyone anywhere in the world to talk directly with anyone else wearing a similar device.

Further ahead, but truly revolutionary, are schemes for Satellite Power Systems. Constructed in space from materials brought up on the Shuttles, these satellites would be platforms several kilometres in length containing "fields" of solar cells which would convert sunlight into electricity and beam it down to Earth as microwaves, where it would be reconverted back into electricity; a limitless supply of pollution-free energy that would end the oil crisis forever.

The scientific uses of Shuttle are very numerous, although some of its immediate applications can be mentioned. Probably the most exciting is the space telescope, the most powerful astronomical instrument ever built. Due for launch in 1983, it has a 2.3 metre diameter and will operate above the murk of the atmosphere where it will detect objects 50 times fainter than any currently observable. This telescope will be able to expand our visual view of the Universe from an estimated three



This Space Telescope is capable of being launched from the Space Shuttle and would orbit the earth at an altitude of almost 500km.

per cent to an incredible 95 per cent.

Other major scientific projects presently planned are the Galileo unmanned missions to Jupiter; the Solar Polar Mission, which aims to hurl two probes out of the Plane of the Ecliptic (the imaginary line along which the planets orbit the Sun, as Saturn's rings orbit the Sun's poles; a solar sailing ship to meet Halley's Comet in 1986; and the European Space Agency's

main contribution, Spacelab, a complete orbital laboratory designed to fit into the Shuttle's cargo bay, where non-astronaut scientists can work in shirtsleeves in a weightless environment for up to a month at a time.

Finally, and not so well known, are Shuttle's military implications; hardly surprising when one considers that the US Department of Defense has not only put billions of dollars into the Shuttle program, but is even building its

This Week...

We present

PART 1 of your

32-page

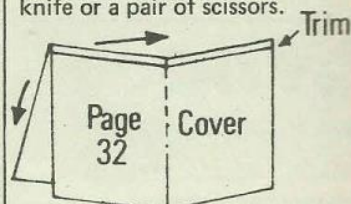
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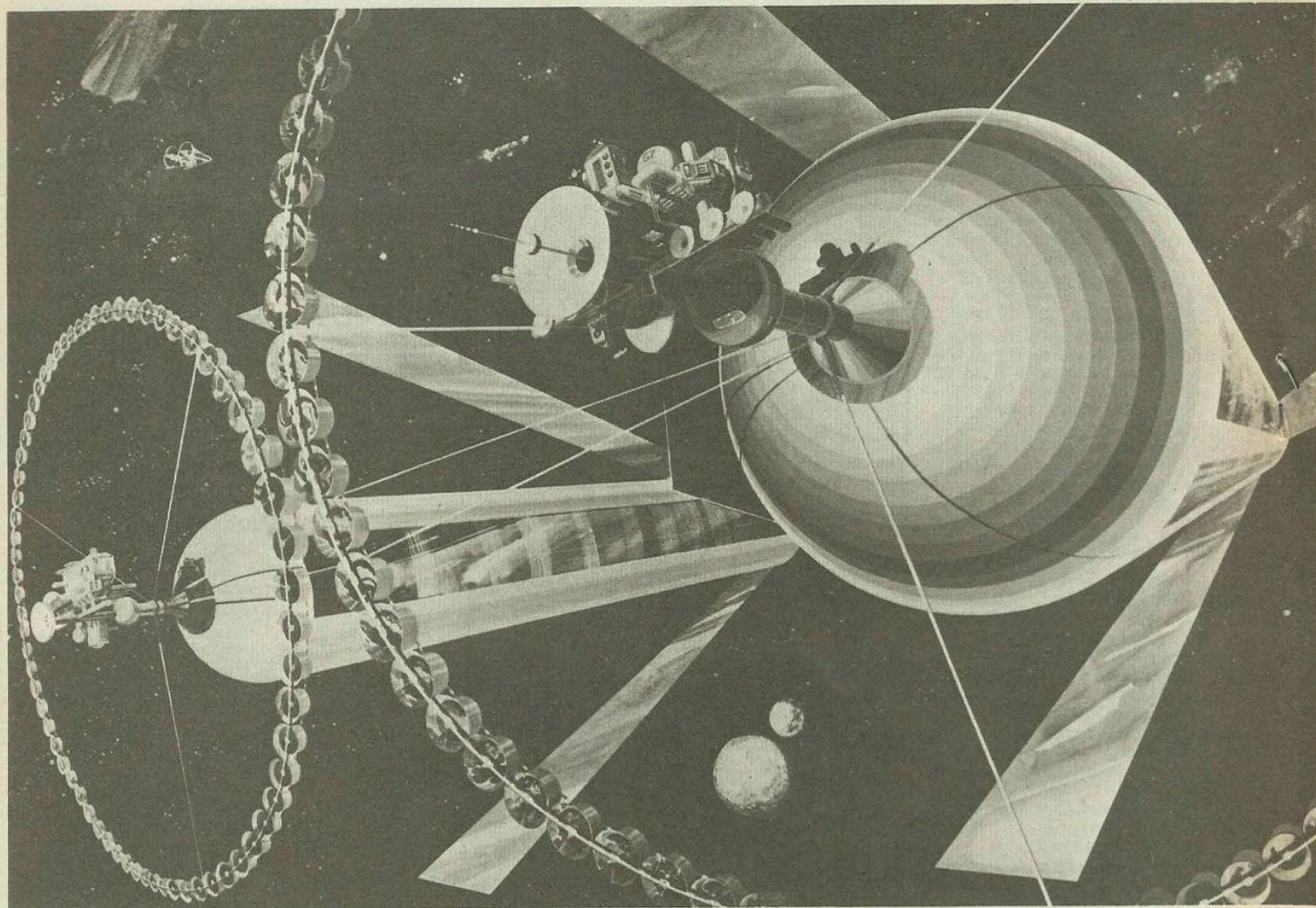
own launch and landing facilities at Vandenberg Air Force Base on the west coast of California; from where it will despatch its own missions manned by its own astronauts into circumpolar orbits over the Eurasian landmass.

Many military functions will be merely extensions of normal commercial uses, such as communication and navigation satellites but, more ominously, Shuttle is an ideal vehicle for 'sowing' batches of spy satellites into low Earth orbits. Being manned and manoeuvrable, it could be easily adapted as a laser-armed "satellite-killer", and could even snatch offending satellites out of orbit and bring them down to Earth.

It is capabilities such as these which disturb the Soviet Union, for without their communications and spy satellites, the armed forces of today's superpowers could be rendered blind and helpless at one fell stroke. It is no exaggeration to say that any major war from the mid-eighties onwards could be decided in space, and this realisation will undoubtedly spur the Russians on to develop an equivalent to Shuttle as soon as they can.

For the time being, however, all eyes remain on *Columbia*, as she is made ready for perhaps her most historic flight. For when astronauts Joe Engle and Richard Truly lift off from Cape Canaveral on 30th September next, they will be the first spacemen ever to be travelling in a "used vehicle".

WHAT NEXT IN SPACE?



As everyone knows, the space shuttle *Columbia* is the first of what it is hoped will be a long line of ever-evolving reusable spacecraft. The ability of *Columbia* and its successors to make multiple flights into space is obviously a major factor in reducing the enormous cost of manned space trips in which none of the expensive hardware could be used again. But perhaps equally important will be their cargo-carrying capacity which far outstrips that of any of their predecessors.

Even the first of the orbiter vehicles, *Columbia*, can carry nearly 30 tonnes into space, and plans are already afoot to increase this towards 60 tonnes on later vehicles. It is this increasing payload capacity which will probably have the greatest impact back on Earth, leading, in stages, to a staggering new source of energy. Ultimately, there could be gigantic self-sustaining space colonies which could give homes to hundreds of thousands, and even millions, of people.

The first stage in this process is known as a Free-Flying Power Module, which is really a small power station built in orbit from

Coming Down To Earth

The establishment of colonies in space could do much to improve living conditions on Earth

materials brought up by the orbiters. Its 32-metre "wings" are composed of solar cells which can convert sunlight directly into electricity. The 25 kilowatts of power produced by the module may be tiny by the standards of Earth-based power stations, but it is huge compared with the internal power systems of the orbiters. These modules will supply, among other

things, the electric power needed to build the next stage, a medium-sized orbiting spaceport which would be a base for the people and materials needed to build Solar Power Satellites.

It is these satellites which offer the best chance of cracking the energy crisis on Earth, which is certain to get worse in the coming years, as traditional energy fuels,

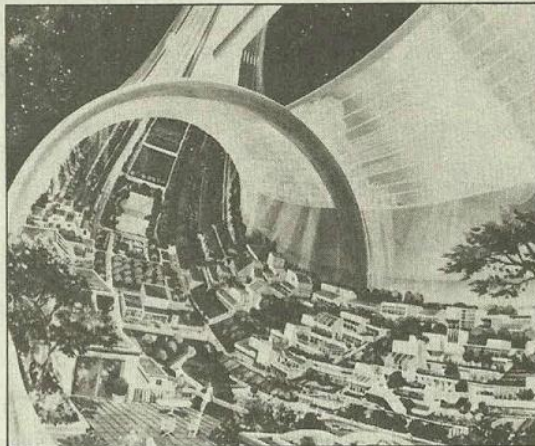
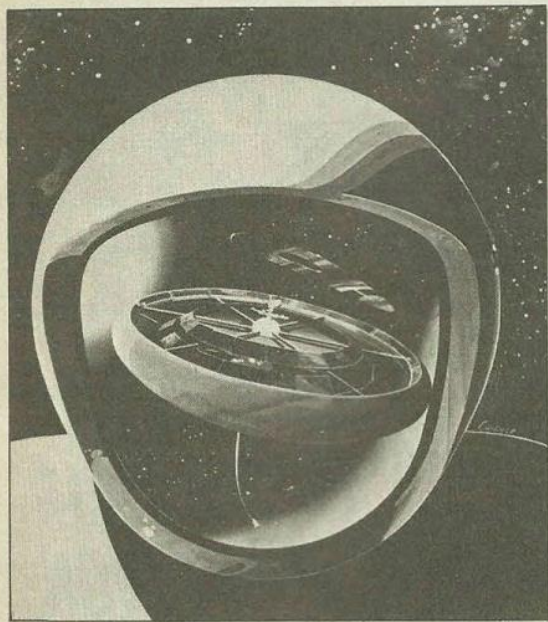
such as oil and coal, are used up. And nuclear power is becoming increasingly less attractive as a source of energy because of environmental and safety concerns.

Solar Power Satellites would be enormous "fields" of solar cells stretching for several kilometres. The structures would be put together in low orbits of a few hundred kilometres, then pushed up to the "geosynchronous" orbit 35,800 kilometres out. At this distance, an orbiting satellite is travelling around the Earth at precisely the same speed at which the Earth itself rotates, and thus appears to hang stationary in the sky above a fixed point.

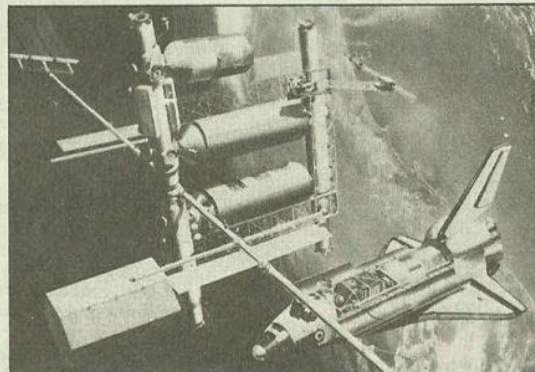
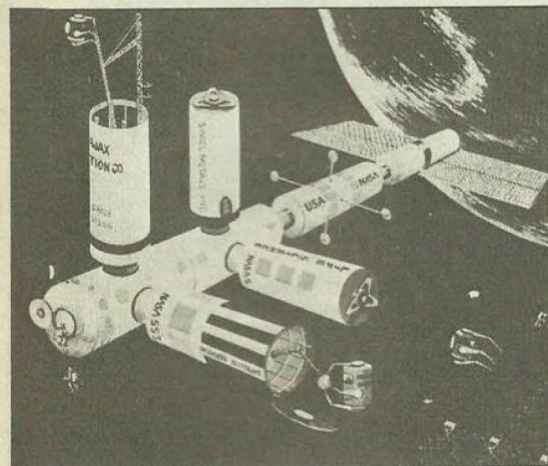
This is the orbital "slot" currently used by communication and navigation satellites. The only worry is that unless their future numbers can be reduced by replacing them with larger, more complex satellites each capable of doing the jobs of several of today's models, a serious "parking problem" could arise in space.

Once placed in geosynchronous orbit, a Solar Power Satellite would be continuously angled towards the Sun, except for brief periods each day when the Earth's

Continued on page 19



21st Century Space Colonies. On the far left is a design for space habitations that could house a population ranging from 200 thousand to several millions, depending on how the interiors are arranged. Left: a colony which would be home for about 10,000 space dwellers. Above: residents of a space colony might have this Earth-like vista for a view from inside their home in space.



Working in Space. Complexes like the one shown on the left would enable industrialists to rent space in Space. Above: An orbiting spaceport designed by the Boeing Aerospace Company.

shadow would eclipse the satellite, cutting off sunlight. Obviously, with several such satellites spaced along the geosynchronous orbit, the majority would still be in sunlight at any given moment. The received solar energy would be turned directly into electricity by the solar cells. This electricity, in turn, is converted into microwaves and beamed down to receiving stations on Earth, to be called rectennas, where the microwaves are reconverted back into electricity and fed into the normal grid system.

The advantages of such a system are considerable. Sunlight is an effectively unlimited source of non-polluting energy and, once built, the solar power satellites would be tapping a free resource. But apart from the enormous investment required — about 100 BILLION dollars on current estimates — the Earth receiving stations, the rectennas, would require approximately 200 square kilometres of land for each satellite in orbit.

Furthermore, the rectennas could only be built between 30 and 40 degrees of latitude. Above 40 degrees, the angle at which the

microwaves strike the Earth increases to such a point that the receivers are no longer effective, while below 30 degrees the angle between the microwaves and Earth's own magnetic field is so small that they may heat up large regions of the Earth's atmosphere, with catastrophic results.

Between these latitudes, however, microwave beams would be of such low power-intensity that they would safely pass through aircraft or birds flying through their paths. It has been predicted that by the end of the century solar power satellites could be providing over 20 per cent of the United States power requirements alone.

One single overriding fact which emerges from this line of future development will be a massive increase of human activity beyond the Earth. This will include not just orbital activity in connection with satellite development, but the probable establishment of permanent bases on the Moon for the mining of mineral and metallic resources which are already scarce on Earth, and certain to become ever more scarce in the future.

This, in turn, could lead to the

development during the first part of the 21st century of self-sustaining space colonies on a truly stupendous scale. Space is a hostile environment, but a relatively "passive" one. In other words, it is easier and cheaper to protect men in Space than on the surface of "actively" hostile worlds like Mars or Venus. By extension, therefore, it is easier and cheaper to build colonies in space rather than on other worlds — thus giving rise to the concept of the space colony.

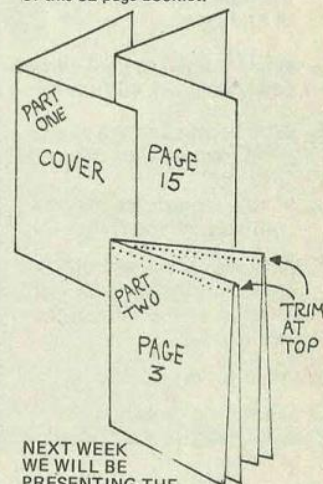
Wheel In Space

Such colonies would be built on the principle of the spinning wheel, rotating around a central axis, or hub, once every 114 seconds. This would create Earth-like gravity around the rim, with the gravity force reducing to zero at the hub of the wheel. An initial colony would be about two kilometres in diameter.

Ideally the colony would be built entirely from materials mined on the Moon, or even from the asteroids, and would orbit the Earth at the same distance as the Moon, thus ensuring that it is always in the sunlight which sup-

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plies its electrical power. The interior of the colony would have an Earth-like environment, even to the extent of growing and producing all its own food requirements, and would pay for itself by industrial output of materials and products which could only be produced in the zero gravity conditions at the hub of the wheel.

Later, such colonies could be as large as 32 kilometres around their circumferences, and 6.5 kilometres in diameter. Depending on how the interior space is utilised, these giant colonies could support populations ranging from 200,000 up to several millions.

While such projects in themselves would do very little to relieve population pressures on Earth, they could do much towards improving living conditions on Earth with the products they could manufacture, and by removing environmentally damaging industries into the neutral safety of space.

Beyond this, such colonies would give rise to a new breed of people, born and brought up in space, people who would have little hesitation in looking for humanity's future in the stars.

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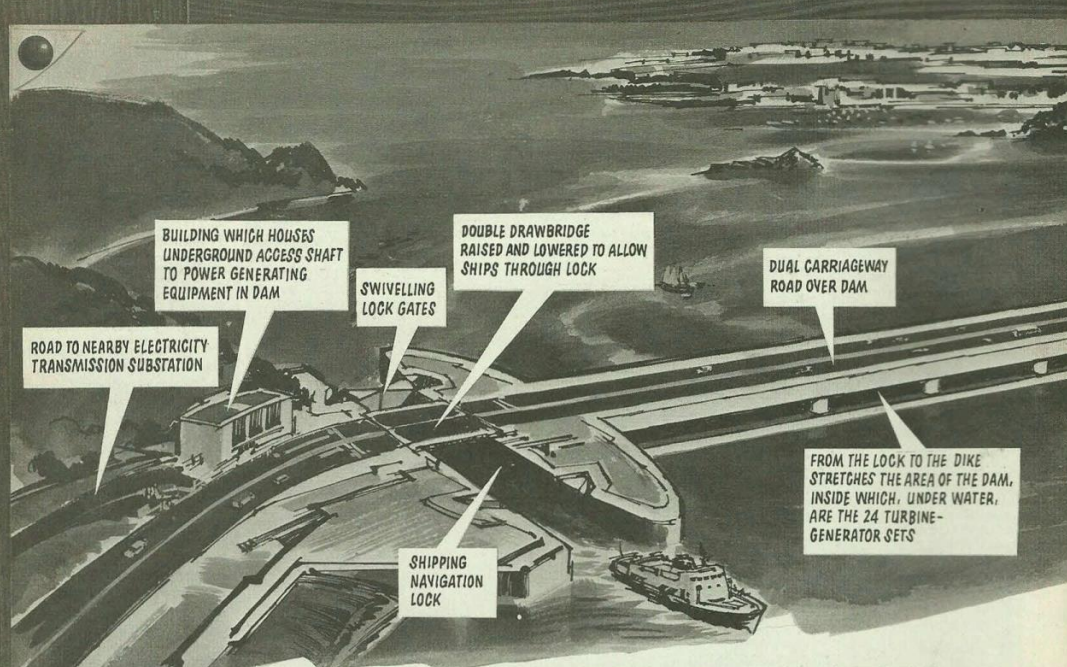
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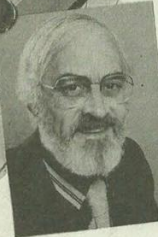




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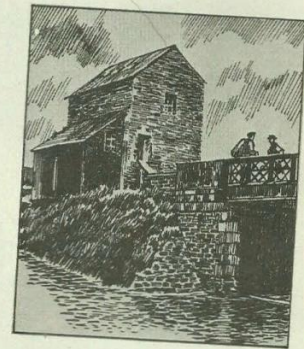
Power From The Sea



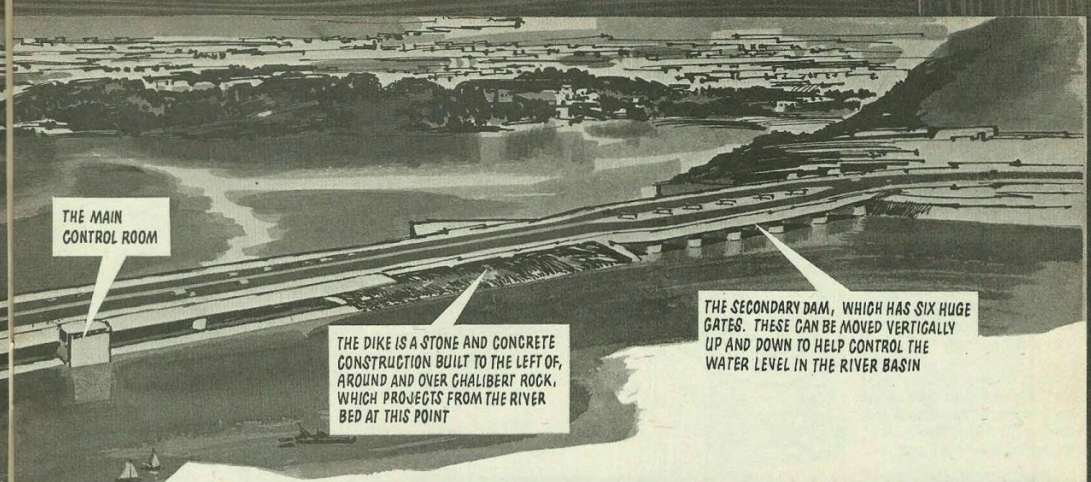
The Rance Power Dam in northern France has proved that the massive strength of the tides can be harnessed as a source of energy

SCHEMES FOR USING WATER POWER TO GENERATE ELECTRICITY ARE OFTEN SPECTACULAR, BUT FEW MORE SO THAN THE 750M WIDE DAM WHICH SITS ASTRIDE THE ESTUARY OF THE RIVER RANCE IN BRITANNY, ON THE NORTHERN COAST OF FRANCE. THE PROJECT, KNOWN SIMPLY AS **LA RANCE**, MAKES USE OF THE MASSIVE STRENGTH OF THE TIDES WHICH RUSH IN AND OUT OF THE WIDE MOUTH OF THE ESTUARY. THOUGH THEIR AVERAGE RISE AND FALL IS 11-4M THEY SOMETIMES RISE TO MORE THAN 13M, SENDING 170 MILLION CUBIC METRES OF TIDAL WATER RUSHING THROUGH THE RIVER'S MOUTH. SCHEMES WHICH USE RIVERS OPERATE BY FIRST DAMMING OFF THE FLOW OF RIVER WATER AND THEN RELEASING IT UNDER GREAT PRESSURE THROUGH PIPES TO SPIN THE BLADES OF TURBINES, WHICH IN TURN SPIN THE CURRENT GENERATORS. IN THE RANCE POWER DAM, THE PRESSURE IS PROVIDED BY FORCING THE TIDAL ESTUARY WATER THROUGH 24 TUNNELS IN WHICH ARE PLACED TURBINES AND GENERATORS.

THE TURBINES OPERATE IN TWO WAYS - TURNING AS THE TIDE RUSHES THROUGH INTO THE RIVER BASIN AND REVERSING THEIR DIRECTION AS IT RUSHES OUT AGAIN TO SEA. THE CONSTRUCTION OF THIS GIANT PROJECT PRESENTED THE ENGINEERS WITH PARTICULARLY DIFFICULT PROBLEMS. THEY HAD TO SHUT OFF AND PUMP DRY A WHOLE AREA, WORKING AGAINST THE FIERCE POWER OF THE VERY TIDES THEY WISHED TO HARNESS FOR GENERATING ELECTRICITY. TO DO THIS, THEY WENT TO HYDRAULIC RESEARCH SCIENTISTS WHO CONSTRUCTED ACCURATE LARGE SCALE MODELS OF THE ESTUARY AND USED SPECIAL EQUIPMENT TO SIMULATE THE TIDAL FLOWS. FROM THESE STUDIES, THE BUILDING METHOD WAS WORKED OUT. HUGE "COFFERDAMS" OR CYLINDERS WERE TOWED OUT AND SUNK ON TO THE RIVER BED UNTIL AN OVAL-SHAPED AREA WAS SEALED OFF AND COULD BE PUMPED DRY. INSIDE THE DOUBLE WALL OF COFFERDAMS, THE BUILDING WENT AHEAD.



THE POWER OF THE TIDES OF BRITANNY HAS BEEN KNOWN AND USED ON A SMALL SCALE FOR CENTURIES. THERE CAN STILL BE SEEN A FEW ANCIENT TIDAL MILLS WHICH USED WATER WHEELS POWERED BY TIDAL FLOW TO GRIND FLOUR. LIKE WINDMILLS AND WATER-MILLS, ONCE USED IN THOUSANDS, THEY ARE NOW ALMOST EXTINCT.

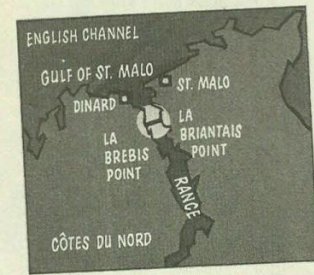


THE MAIN CONTROL ROOM

THE DIKE IS A STONE AND CONCRETE CONSTRUCTION BUILT TO THE LEFT OF, AROUND AND OVER CHALIBERT ROCK, WHICH PROJECTS FROM THE RIVER BED AT THIS POINT

THE SECONDARY DAM, WHICH HAS SIX HUGE GATES. THESE CAN BE MOVED VERTICALLY UP AND DOWN TO HELP CONTROL THE WATER LEVEL IN THE RIVER BASIN

DIAGRAM A SHOWS IN CLOSE-UP A CUTAWAY SECTION OF ONE OF THE 24 "BULB SETS" OF LA RANCE. EACH CONSISTS OF A BULBOUS METAL SHELL, SUPPORTED BY FIXED GUIDE VANES, IN A FIXED HORIZONTAL UNDERWATER TUNNEL. THE SHELL CONTAINS AN ALTERNATING-CURRENT GENERATOR LINKED TO THE SHAFT OF A FOUR-BLADE TURBINE WHICH IS AT THE SEAWARD END. A VERTICAL SHAFT ENABLES ENGINEERS TO CLIMB DOWN INSIDE THE SHELL FOR MAINTENANCE AND REPAIRS. THE TURBINE SPINS AT 94 REVOLUTIONS PER MINUTE AND OPERATES IN BOTH DIRECTIONS, THUS TAKING ADVANTAGE OF THE TIDAL FLOW BOTH WAYS.



THE MAP SHOWS THE POSITION OF THE RANCE ESTUARY DAM. THERE IS A CONSIDERABLE FLOW OF ELECTRIC POWER ACROSS THE CHANNEL. FRANCE HAS ENORMOUS HYDRO-ELECTRIC POWER RESERVES WHICH BRITAIN, WHICH HAS TO RELY MAINLY ON THERMAL (COAL OR NUCLEAR) POWER STATIONS, IS ABLE TO DRAW ON.

BY 1967, LA RANCE WAS IN PARTIAL OPERATION PRODUCING 208 MILLION KILOWATTS PER HOUR. IT NOW PRODUCES ABOUT 500 MILLION KILOWATTS PER HOUR - ONE PER CENT OF TOTAL FRENCH POWER PRODUCTION. ALTHOUGH SCHEMES FOR SIMILAR BARRIERS ACROSS THE SEVERN ESTUARY IN BRITAIN AND ACROSS PASSAMAQUODDY BAY, BETWEEN MAINE, U.S.A., AND NEW BRUNSWICK, CANADA, HAVE BEEN STUDIED, LA RANCE IS SO FAR THE ONLY TIDAL HYDRO-ELECTRIC INSTALLATION IN THE WORLD TO PRODUCE ELECTRICITY ON A COMMERCIAL SCALE.

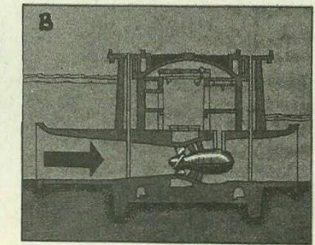
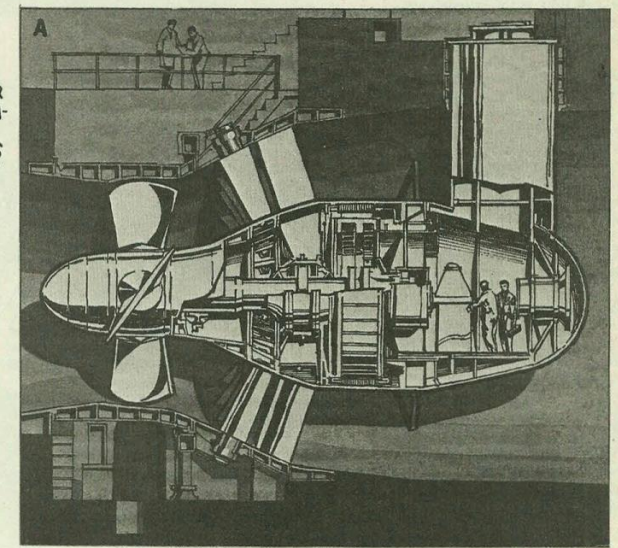
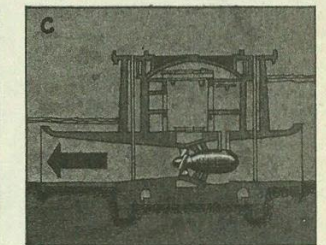
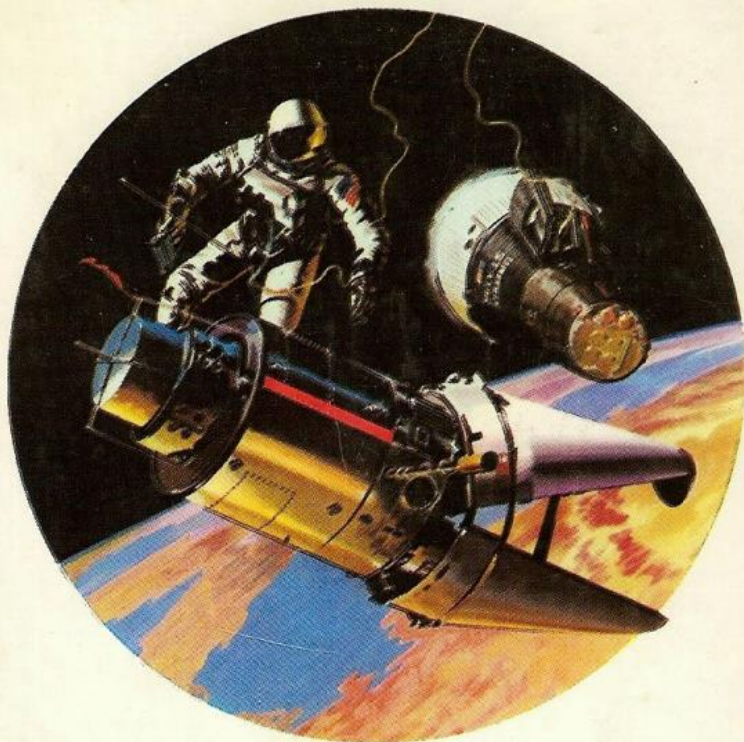
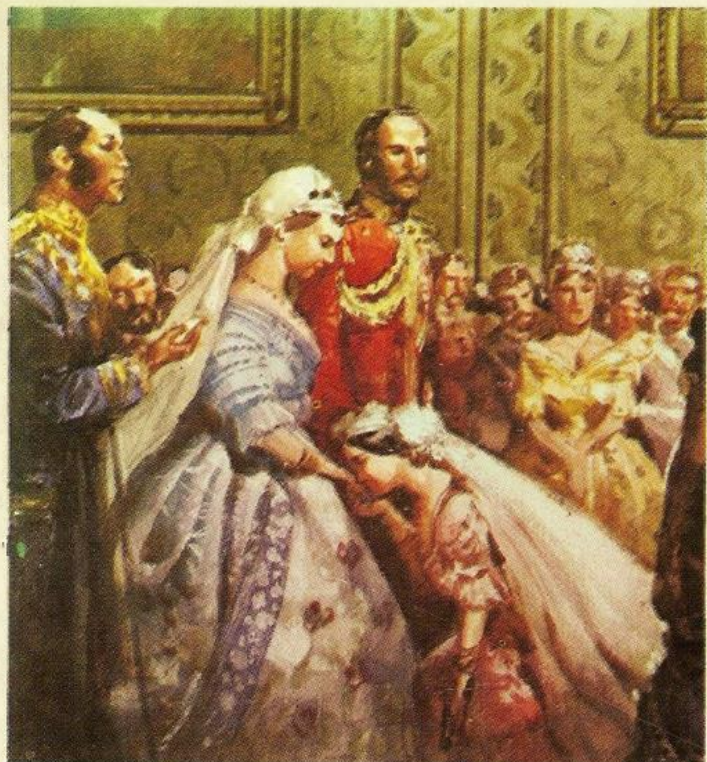


DIAGRAM B SHOWS THE POSITION OF THE TURBINE TUNNEL IN THE DAM, WITH THE CAVERNOUS STATION WORKING AREA ABOVE. THE INCOMING TIDE FORCES WATER INWARDS THROUGH THE TUNNEL AND SPINS THE TURBINE BLADES.

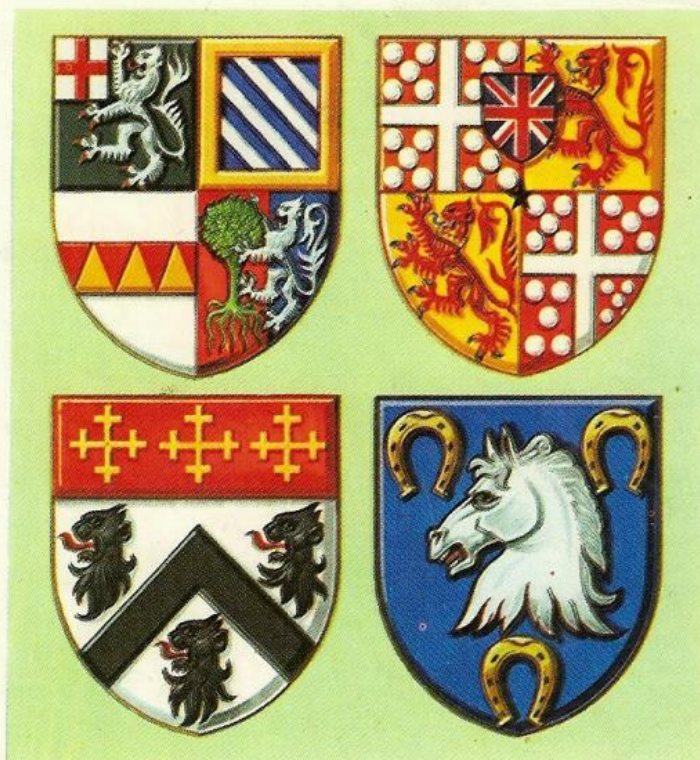
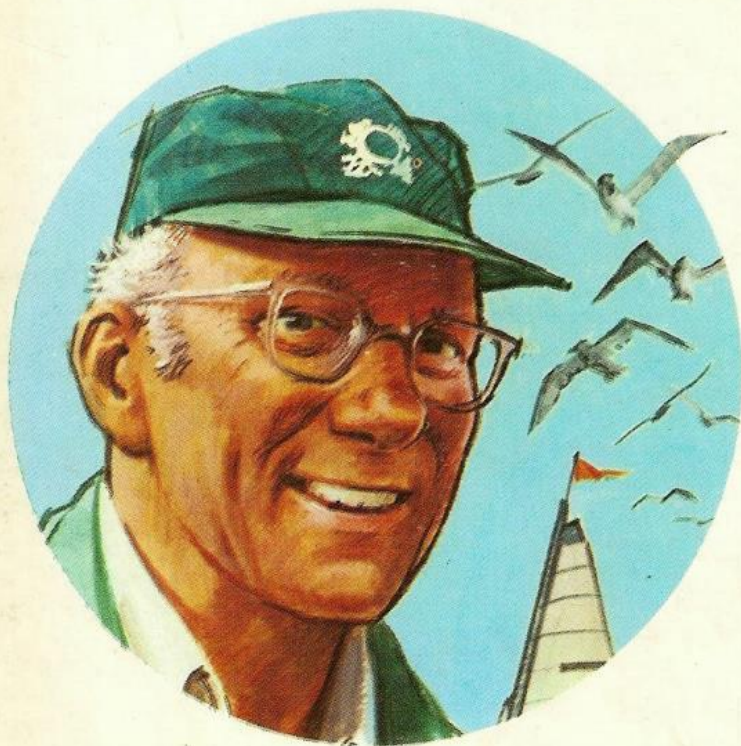


IN DIAGRAM C, THE WATER FLOW IS REVERSED AS THE TIDE RETREATS. PRESSURE ON THE RIVER BASIN SIDE FORCES THE WATER BACK PAST THE TURBINE AND SPINS IT IN THE OPPOSITE DIRECTION.



LOOK AND LEARN

BOOK 1970



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WHAT NEXT IN SPACE?



After meeting the challenge of the Moon, the world's astronauts must turn their eyes to more distant planets . . .

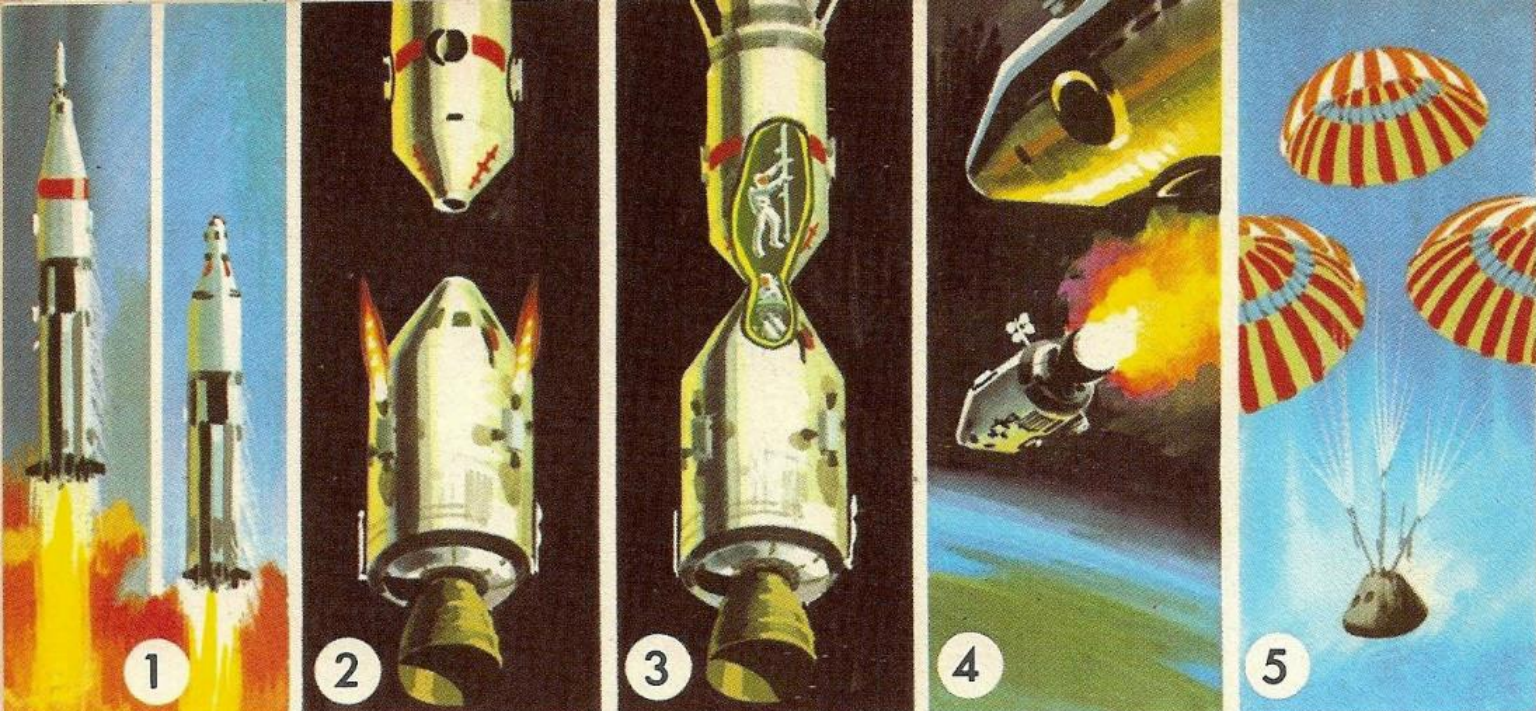
THE race to land on the Moon and explore its surface has led America and Russia to develop huge booster rockets to lift heavy payloads into space, and to develop spacecraft which are capable of keeping small groups of astronauts alive and healthy for long periods of time.

The next steps which America plans to take in space are an extended exploration of the Moon's surface, and a manned Earth-orbiting space station.

The space station is part of the "Apollo Applications Programme", so-called because the equipment used will be adapted from rockets and spacecraft designed originally for the present "Man on the Moon" project.

Scientists have formulated certain basic questions about the nature and origin of the Earth, the Moon, the Sun, and the Universe as a whole which they believe can be answered by observations made in Earth orbit by astronauts operating special equipment.

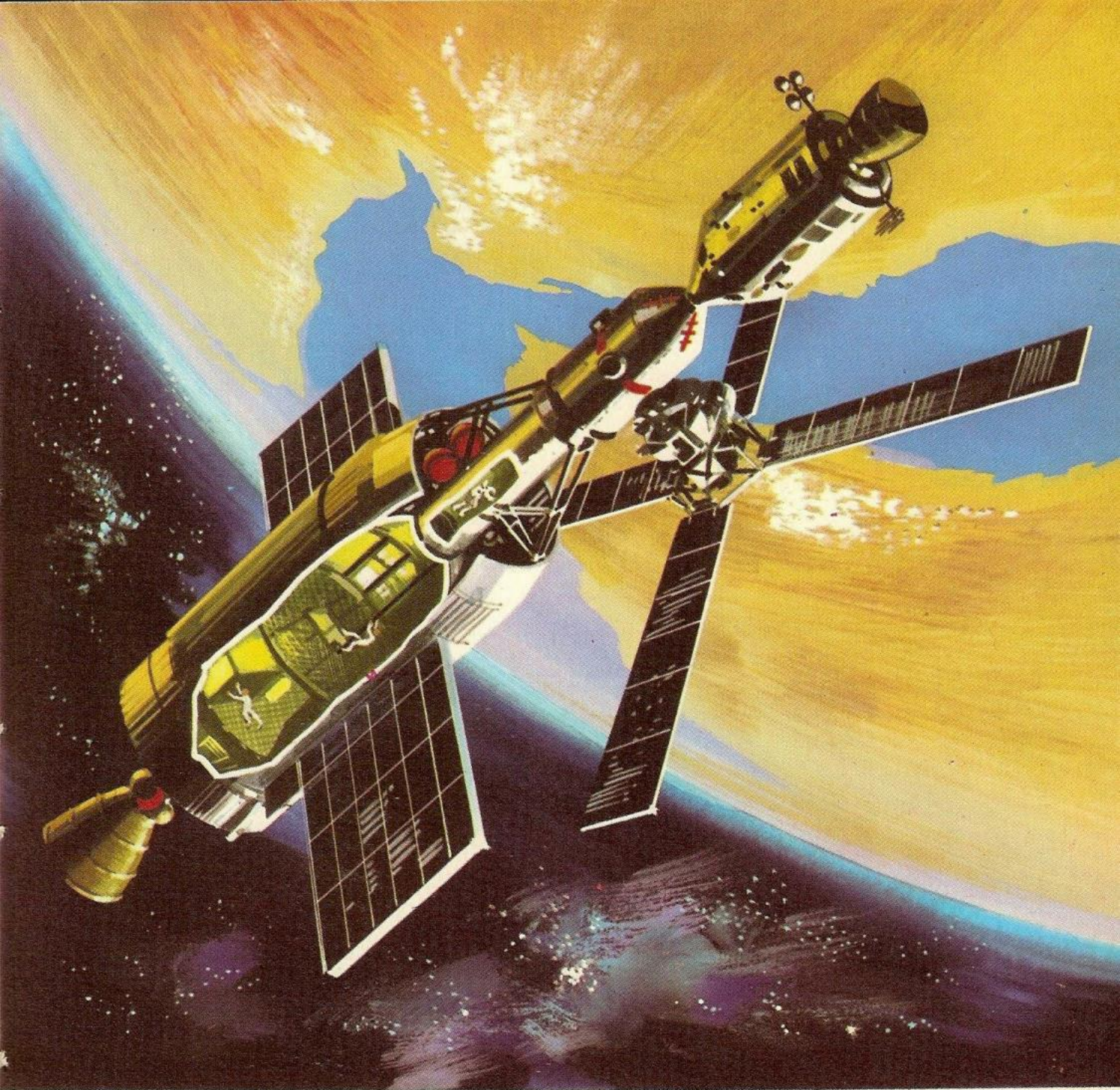
The crews and their equipment will be housed in the simplest of space stations—a huge booster rocket fuel tank! The rocket, a type which forms the third stage of the Saturn Moon booster, will lift into orbit under its own power after a helping boost. It will be fitted with an airlock for entry and exit in space, and two "floors" of open gratings which will provide a working surface, but not impede the flow of fuel as it drains from the tank to the rocket motor. Once in orbit, the space station would await the rendezvous with its crew who would reach it by means of another capsule fired into orbit earlier. Orbiting space station crews would remain on duty for periods of about two to three weeks at a time.



These diagrams show how a three-man orbiting space station would be placed in position above the Earth. (1) A Saturn rocket lifts the crew into a 'parking' orbit above the Earth. Four days later, the adapted space station is boosted into orbit, unmanned but ready for use. (2) The Apollo Command and Service Module makes rendezvous with the station, and is steered delicately into position by the firing of small thruster rockets. (3) Once the Apollo craft is securely attached, the crew open the nose hatch, and crawl through into the space station airlock tunnel. Here, they activate a system to clear the last dregs of fuel from the tank interior. They then enter to begin their work. Once inside, the crew will take off their weighty

and cumbersome space suits, and work in a comfortable weightless short-sleeve environment. (4) When they want to return to the Earth's surface at the end of their tour of duty, the crew re-enter their command module, detach it and fire its motor to slow it down for re-entry into the atmosphere and (5) an eventual parachute landing in the sea where waiting ships will pick them up in the usual way. A great deal of information about the Earth itself, and its surroundings in space will be available from observations made by the astronauts in the space station (see below), and they will also make observations of other stars and planets in the solar system unhampered by the restriction which the Earth's envelope of air places on astronomers here.





Geological Survey	Soil conditions	Crop conditions	Ice and Sea surveillance	Coastal mapping	Ocean current mapping	Fish and plankton movement	Astronomical observations

The Mercury, Gemini and Apollo Earth-orbit flights have already produced photographs and observations of a clarity and detail which has astounded scientists. The future possibilities of the orbiting space station are endless. Some of the observations which can be made are shown above. Specially developed cameras and techniques of many types can be used to show up dramatically a range of information for the use of experts in almost every field of study of our planet's land, sea and atmosphere.

After its first period of work, the station will be shut down

and left in orbit. During its second period of use, a modified Apollo Moon Landing Vehicle, will be boosted up and attached to it. This vehicle, called the Apollo telescope mount, will be fitted with numerous astronomical observation devices. (This is the windmill-like object in the large illustration above. The 'windmill' blades are solar paddles which collect energy from the sun's light. The 'wings' on the space station itself serve the same purpose.)

In future, communication relays and networks may be operated from stations like this one, surpassing any we have today.

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FROM MOTORWAYS TO SKYWAYS

Will the cars of the future take to the air?
 See Supplement

FLYING CARS



The Ave Mizar was a Ford Pinto and Cessna Skymaster. It spanned 38 ft. 2 in. (approx. 11 metres) and was 29 ft. 6 in. (about 8 metres) long. Level air speed was 156 mph (250 kmh.) with a ceiling of 12,000 ft. (3657 metres). Landing run for the vehicle was 475 ft. (143 metres). The Pinto was standard, with four seats.

With wings folded, this Autoplane could touch 60 mph (96 kmh.) on the road and 90 mph (144 kmh.) as an aircraft, powered by a pusher aero engine. Built in America in the 1950s, it cost around £500.

How often have we sat in a long traffic queue, wishing our cars could sprout wings and fly? In America, a number of enterprising men have tried just that and married a car to an aeroplane!

IN RECENT years, there have been only a handful of flying car designs that have worked efficiently; the problem is to build a vehicle that has a good performance in the air and on the ground. One American has been working on his aerial car for no less than 26 years!

As you can see, most of the flying cars are completely original designs rather than a mating of standard aircraft and automobile parts.

The reason for this is that, of course, neither machine is built to do the job the flying car men want!

Recently, however, Advanced Vehicle Engineers of America

put together a sleek Ford Pinto and the wings and tail booms of the Cessna Skymaster. The pusher engine of the aircraft was attached to the back of the road vehicle, which used its standard engine when on the ground.

Unfortunately, the Mizar, as this design was called, crashed, killing the man whose brainchild it was.

In these days of ever-rising fuel costs, we may yet see a successful car-cum-aeroplane take to the skies and be economical enough to enjoy high sales, but there are a number of problems to be overcome before such a startling idea becomes reality.

Although not the prettiest aerial car, the Fulton Airphibian was another 1940s design. It flew at 110 mph (177 kmh.) and had a range of 350 miles (563 km.) as a plane. One person could convert it to a car in just seven minutes.

From experience with his Aerocar range, US designer Moulton Taylor has projected this neat "homebuilt" Aerocar Imp, which is more aircraft than car.

Above: Since 1948 the Aerocar company has been working on the flying car idea. This one is the Model III with a custom body shell.

LOOK AND LEARN

Focus on THE JET AGE

Fire-breathing "dragon," or rocket, propelled by gunpowder, carried messages across valleys in Ancient China.



Comet I was the first jet passenger plane. It had four turbojet engines in its wings, flew at 500 m.p.h.



The Viscount uses jet engines which drive propellers. It burns less fuel than the Comet and is used for short flights.



Comet IV is an improved version of Comet I. It can carry seventy-six passengers and cruises at over 500 miles per hour.



The Caravelle has two engines mounted at the rear of the fuselage. The Comet IV and the Caravelle take off steeply and so only need short runways.



The Boeing 707 was the first American jet transport plane. It is mainly used for transatlantic services.



This supersonic aeroplane will travel faster than the speed of sound. The fuselage has to be very carefully constructed to protect the aircraft from the very high stresses experienced at great heights.

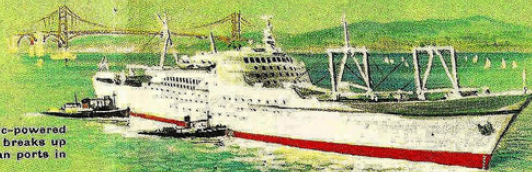


This plane rises straight up from the ground by means of engines pointing downwards. In the air it is propelled forwards by turbojets.



Nautilus was the world's first atomic-powered submarine. It can go round the world without refuelling, and carries a crew of nearly a hundred men.

Lenin is the first atomic-powered ship to be put into use. It breaks up ice to keep open the Russian ports in the Arctic.

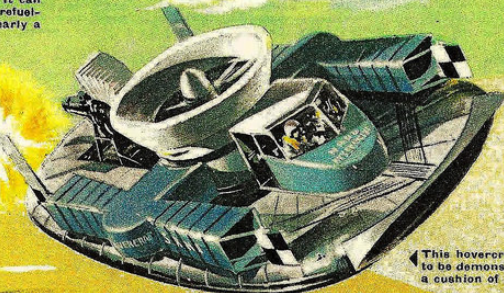


The Savannah is an experimental atomic-powered ship that will carry passengers and cargo. It was built in America and is seen here lying in San Francisco bay.

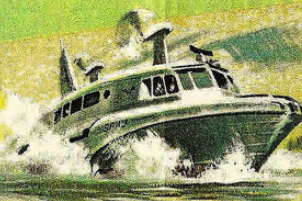
An artist's idea of a submarine of the future. This atomic-powered cargo submarine will cross the Atlantic at high speeds more than 250 feet below the surface. She will be able to carry 20,000 tons of cargo.



1959: THE HOVERCRAFT EXPLODES ON THE SCENE



This hovercraft is SRN 1, the first hovercraft to be demonstrated in England. It hovers over a cushion of air, and can cross land or sea at great speeds.

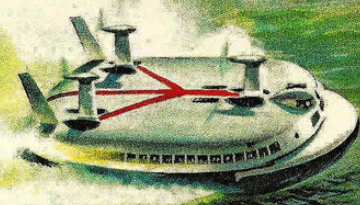


SRN 11 is a passenger hovercraft. It looks like a ship and can carry forty-four passengers. Some day we may be able to go to America in one of these.

This farming hovercraft is now being offered to farmers for £3,550. It hovers over fields and can be used to spray seedlings without hurting them, but it cannot clear hedges.



Hovercrafts of the future... A sea hovercraft will be able to carry 600 people, together with their cars and luggage.



An artist imagines a "maid of all work" hovercraft. It will cross any except very bumpy land, carrying people and equipment.



The Rover T4 has a jet turbine engine very like the engine in the Viscount aeroplane. Its engine is much lighter than that of an ordinary car, and the turbine will rise to maximum speeds in twelve seconds.

A specially modified aeroplane engine is used in this record-breaking car. In good conditions it can travel at over 350 m.p.h.





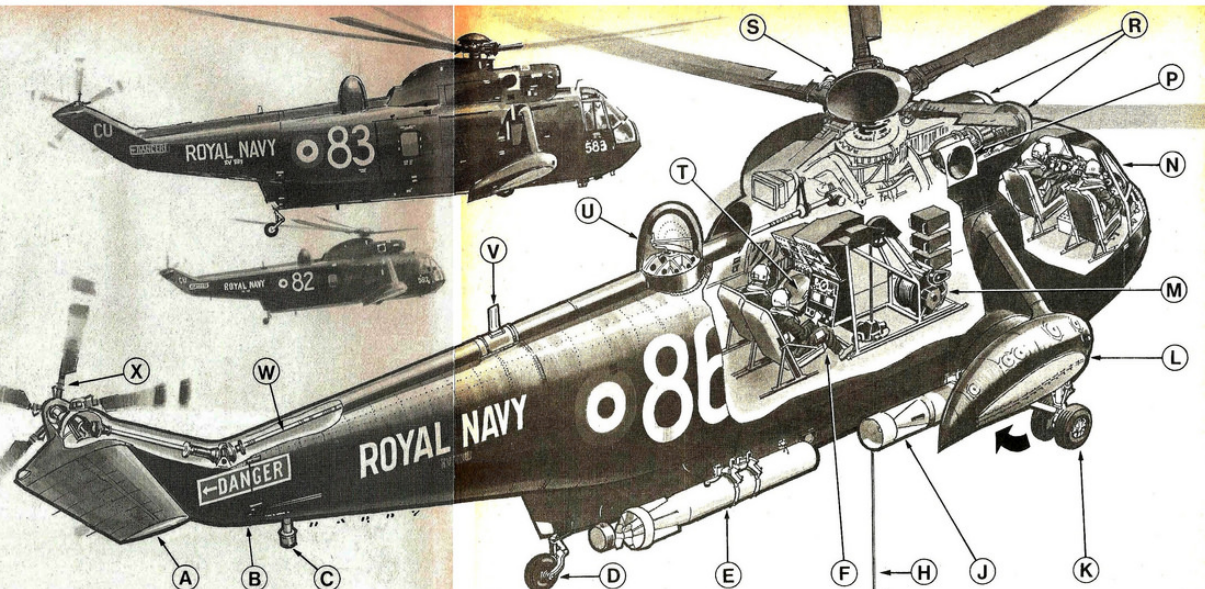
THE SUB KILLER
SEE PAGE 14

THE SUB KILLER

One of the Royal Navy's most modern and powerful weapons in ASW— or anti-submarine warfare—is the big Westland SH-3D Sea King helicopter. Designed to operate from shore bases or ships, it will form a major part of the all-helicopter force which Royal Navy crews will operate when the last of the Fleet Air Arm's fixed-wing aircraft have been transferred to the Royal Air Force in the late 1970s.



The key man in an anti-submarine hunt is the observer, who receives all the position, depth, speed and distance information on his radar screen. He may co-ordinate the attacks of a "pack" of other helicopters and surface ships. The observer's correct title is Anti-Submarine Control Officer.



A. Fixed tailplane.
B. Hinge point where the tail folds forward for ground or deck storage.
C. Transponder aerial which transmits an aircraft identity signal automatically when interrogated.
D. Fixed tail wheel.
E. Homing torpedo weapon.
F. Sonar operator's position.
G. Sonar buoy.
H. Sonar cable.
I. Depth charge (the weapon load is not normally mixed. Four depth charges or four torpedoes are carried, according to the water depth in the patrol area).

K. Twin-wheel main under carriage unit (retracted in flight).
L. Sponsons which house the undercarriage (they are fitted with inflatable buoyancy bags for emergency sea landings).
M. Sonar cable winch drum.
N. Cockpit housing two pilots and extensive automatic pilot equipment.
O. Engine exhaust.
P. Air intakes to twin turbine engines.
Q. Five-blade rotor which folds back for stowage.
R. Observer's tactical radar display.
S. Search radar scanner.
T. UHF radio aerials.
U. Drive shaft from engine to tail rotor.
V. Five-blade rotor.



The sonar operator must be skilled in interpreting all the information his underwater "ear" sends him. He must learn, for instance, the difference between the echoes from a submarine lying silently on the sea bed and a wrecked ship.

THE Sea King, a British-built version of the Sikorsky 5-61B helicopter, is powered by two Bristol-Siddeley Gnome 1400 gas turbines, which spin the five-bladed main rotor and tail rotor. The use of twin engines, which makes a complete engine failure highly unlikely, is very desirable. Normally, when an engine fails, the gyro is put into "autorotation." When this is done, the helicopter can float to the ground with the rotors spinning freely by air pressure.

To make the switch from powered flight to "free wheeling" takes a certain length of time. If the helicopter is hovering 40 feet above the sea, it would hit the water before the change could be made. Hence the need for the second engine. The adaptability of the Sea King allows it to carry out a variety of roles, including air/sea rescue, troop and cargo transport, minesweeping and finding and destroying hostile surface vessels. But for its main anti-submarine task, it is packed with advanced electronic equipment. This makes it a completely self-contained unit so that, although it does not normally operate alone, it

can by itself detect, classify and destroy a modern high-speed submarine. At maximum fuel load, the Sea King can stay in the air for about four hours. It flies out to its assigned patrol area which may be, for instance, ahead of a group of friendly ships. Once there the pilots head the helicopter into the wind and feed their instructions into the autopilot. This takes over, holding the correct height and position.

UNDERWATER "EAR"

The sonar operator now lowers the buoy on its cable into the sea. Each "dunking" of the sonar (or underwater "ear") lasts about six to ten minutes. The man in charge is the observer, known officially as the anti-submarine control officer, who sits at a tactical radar display on which he sees the contact from the sonar, and the blips of radar contacts from all other helicopters, aircraft and surface ships in the area. He directs any attack which is made, controlling his own aircraft or a group of aircraft and, if the situation demands it, surface ships as well, in a

co-ordinated closing of the net. The weapons the Sea King carries are usually four torpedoes or four depth charges. The Mark 44 light-weight torpedo is a "homing" weapon which aims itself at the target. It is released from the helicop-

ter and is fused automatically as it drops away, falling by parachute for a soft landing in the sea before heading under the water to its target. The Mark 41 depth charge is for use in shallow water, where it is more suitable than a torpedo.

Australia 25 cents. New Zealand 25 cents. South Africa 30 cents. Rhodesia 32 cents. Nigeria K. 25. Canada 35 cents. Malaysia 80 cents. Malta 11c. 3



AMERICA'S DEADLY DOGFIGHTER —INSIDE

SCIENCE SURVEY



Above: a cutaway sketch of the YF-16 fighter plane, showing its main features. Left: the pilot's seat is tilted back to an angle of thirty degrees to offset the gravitational pull.

AMERICA'S DEADLY DOGFIGHTER

FIND your enemy, get him in your sights and shoot him down. That is the job of a fighter pilot in war. And the American Air Force is making sure that he has the right tools to do it with.

They have just carried out the first test flight of a prototype single-seat, single-engine aeroplane that will have a top speed twice as fast as sound and a rate of acceleration double that of the best fighters now in use.

Named the YF-16 and made by General Dynamics, it will be able to operate in a radius of 500 nautical miles, striking at enemy fighters with its 20mm. multi-barrel cannon, for which 500 rounds of ammunition are to be carried.

Air-to-air missiles, that home on their target by its infra-red radiation, will be fixed on each wing tip.

To offset the gravitational pull caused

by the terrific speed, the pilot's seat will be tilted back to an angle of thirty degrees and the control stick will be at his side instead of between his legs. Over him will be a frameless, transparent canopy which provides all-round vision.

With a length of 47 feet and a wingspan of 30 feet, the YF-16 is designed for daytime operation. Two prototypes are being made, and, if these are successful, the aircraft could go into production at the rate of a hundred a year for a cost of about £1½ million... each!

But, that is not dear for an aircraft. If it is bought by nations which are friendly towards America, as the designers anticipate, it should mean that aerial dogfights of the future will be accurate and deadly, with victory going to the nation with the best planes. But such planes also have a deterrent value, proving that peace is worth safeguarding.